Journal of Conventional Weapons Destruction

Volume 20
Issue 2 *The Journal of Conventional Weapons Destruction*

Article 1

July 2016

The Journal of Conventional Weapons Destruction Issue 20.2

CISR JMU
Center for International Stabilization and Recovery at JMU (CISR)

THE JOURNAL of Conventional Weapons Destruction

Issue 20.2 | July 2016

In the Spotlight: SOUTH and CENTRAL ASIA

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THE JOURNAL OF CONVENTIONAL WEAPONS DESTRUCTION
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ISSUE 20.2 | JULY 2016 | ISSN: 2469-7575
- *The Journal of Conventional Weapons Destruction*
  Issue 20.1 ongoing: (print) ISSN 2469-7575 (online) ISSN 2469-7605
- For previous ISSN numbers visit www.jmu.edu/cisr/journal/about.shtml

The Journal of Conventional Weapons Destruction is a professional trade journal for the humanitarian mine action and CWD community. It is a forum for best practices and methodologies, strategic planning, risk education and survivor assistance.

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THE JOURNAL of Conventional Weapons Destruction

ISSUE 20.2 | JULY 2016

IN EVERY ISSUE...

Editorial

4 Director's Message

5 Implementing International Obligations to Clear Mines by Stuart Casey-Maslen

Field Notes

37 The UXO Sector in Laos
by Titus Peachey

42 Armed Violence Reduction in Central Mali: A Community-based Approach
by Sonia Pezier and Jean-Denis Larsen

45 Explosive Remnants of War: A Deadly Threat to Refugees
by Dr. Ken Rutherford and Andrew Cooney

51 Finding Legacy Minefields in the Jordan Valley
by Jamal Odibat

RESEARCH AND DEVELOPMENT

54 Flail Technology in Demining
by Ashish Juneja

63 Maximizing the Effectiveness of Mobile Technology
by Howard Rudat

65 Endnotes

COMING IN ISSUE 20.3 | NOVEMBER 2016
FEATURE: SA/LW and CWD
SPOTLIGHT: Middle East & North Africa

COMING IN ISSUE 21.1 | MARCH 2017
FEATURE: Improvised Explosive Devices
SPOTLIGHT: East Africa

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ON THE COVER:
Ordnance identified with the CORD database in T-IMS ordnance module. Mobile technology development is working to improve data quality.
Photo courtesy of Spinator AB.

FEATURE

MOBILE TECHNOLOGIES IN CWD

7 **Mobile Data Collection: Interoperability Through New Architecture**
by Elisabeth Vinek, Sulaiman Mukahhal and Olivier Cottray

12 **From the Field: Mobile Technologies for Mine Action**
by Torsten Vikström

17 **Mobile Technology in Mine Action: The Fulcrum Application**
by Camille Wallen and Nick Torbet

21 **Mobile Technologies: UXO Lao's Easy Sketch Map**
by Hayashi Ontoku Akihito

SPOTLIGHT

SOUTH & CENTRAL ASIA

24 **Integrated Cooperation on Explosive Hazards Program in Central Asia**
by Luka Buhin

30 **Building Tajikistan's National Capacity**
by Bahriniso Shamsieva

33 **Afghanistan's National Mine Action Strategic Plan (2016-2021)**
by Mohammad Akbar Oriakhil

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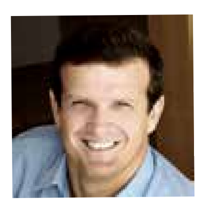
FROM THE DIRECTOR

In continued celebration of our 20th anniversary, James Madison University (JMU) honored CISR at a JMU's annual Capitol Hill reception in Washington, D.C. on 10 June 2016. Attended by Director Stan Brown from the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), JMU President Johnathan Alger, nearly 200 JMU area alums, and mine action friends from Legacies of War, Marshal Legacy Institute and the Organization of American States, the event celebrated CISR's legacy in a fantastic evening with friends and colleagues. With a full house of around 200 guests, both Brown and Alger offered warm sentiments and recognized the strong commitment of those in the industry to have a lasting impact on the world. As the field of humanitarian mine action and conventional weapons destruction (CWD) continues to adapt and evolve, we celebrate our past while looking to our future.

In this issue, we're excited to feature mobile technologies, their benefits, challenges and current usage in programs around the world. Camille Wallen and Nick Torbet from The HALO Trust discuss their experience using the Fulcrum mobile application to collect and analyze data in Laos. Elisabeth Vinek, Sulaiman Mukahhal, and Olivier Cottray from the Geneva International Centre for Humanitarian Demining (GICHD) look at how the newly adopted IMSMA development strategy will foster better interoperability between the national storage component, IMSMA Core, and other external applications. Torsten Vikström from Spinator AB presents the EU-funded TIRAMISU Information Management System (T-IMS), a mobile field data collection tool for humanitarian demining that was field tested in Croatia by deminers and surveyors from the Croatian Mine Action Centre. And Hayashi Ontoku Akihito, a Japan International Cooperation Agency adviser to the Lao National Unexploded Ordnance Programme, reports on the Easy Sketch Map application, which facilitates more efficient, on-site map making.

Our next (Fall 2016) issue will spotlight the Middle East and North Africa: How are illicit small arms and light weapons (SA/LW) and CWD proliferation currently affecting these regions? What broader issues are connected to illicit SA/LW (public health, gender, youth, crime)? In addition, issue 20.3 will feature articles on weapons marking and tracing, how illicit weapons affect humanitarian deminers' and community safety, as well as creative ways to reduce the negative effect of illicit SA/LW in communities while improving weapons ammunition security.

Moreover, I'm excited to announce that we have released topics for issues 21.1, 21.2, and 21.3, which will encompass improvised explosive devices (IEDs) and pressure plate IEDs—a new focus for *The Journal*—as well as a special report section on Bosnia and Herzegovina twenty years following the end of the Bosnian War in December 1995 and the Balkan floods of May 2014. For more information on upcoming topics, please visit us online at www.jmu.edu/cisr.



Ken Rutherford
CISR Director

Photo courtesy of Missouri State University Photo Services

Implementing International Obligations to Clear Mines

by Stuart Casey-Maslen

Each State Party to the *Anti-Personnel Mine Ban Convention* (APMBC) that knows or suspects it has areas under its jurisdiction or control that contain anti-personnel (AP) mines has a clear deadline to locate and destroy those mines. According to Article 5(1), upon becoming party to the APMBC, a State must complete clearance within ten years, unless the deadline is pushed back in an agreement from the other States Parties at an annual meeting or five-yearly review conference.[1]

The nature of the obligation is to make every effort to find all mined areas with AP mines in areas located on sovereign territory or on territory a State effectively controls abroad. Once a suspected mined area is confirmed as contaminated, the State Party must then destroy **all** the AP mines contained therein. In practice, however, all does not really mean all. This is the understandable result of technological constraints allied to the explicit introduction of risk-management methodology into demining operations. Detection technology limits the depth at which AP mines, especially those with minimum-metal content, will be identified. Mines that lie more than a dozen or so centimeters below the surface will likely remain undetected; however, some may rise in the months or years following clearance operations, presenting an ongoing threat to life and limb. Similarly, a decision must be taken as to which areas are subjected to full clearance and at which point this will start and end. The result of this decision may be that actual contamination is unwittingly overlooked.

In reality, the problem with demining is less that adjacent areas contaminated with mines are missed. Far more often, operations focus and persist in areas that palpably are not contaminated with explosive devices, which impede efficiency. Poor survey techniques and fear of legal liability in some instances meant that operators and national programs have eschewed risk-management methods in favor of ultra-cautious (and ultra-expensive) approaches. Any ongoing mine clearance operation that does not locate a single mine (or other explosive threat) within ten days should ask itself whether it is working in the right place.

But while many States Parties seem to regard time as an infinite resource, funds—whether national or international—are most assuredly not. Even without the dictates of financial austerity and blossoming budget deficits, funding for mine clearance operations would already be in decline. The increasingly steep decline that we are currently witnessing will only accelerate in coming years, though major support for specific operations will likely still be available in case of overriding humanitarian need (e.g., should peace break out in Syria).

What does this mean for the implementation of the APMBC?

First, the generosity of extension periods with which States Parties have too frequently rewarded sluggishness and inefficiency must come to an end. Granting long extensions to laggard programs scarcely encourages positive change. Moreover, if a State Party is willfully failing to make every effort to confirm mined areas and then clear them "as soon as possible" (as Article 5 demands), they should not be granted an extension.[1] The legal reality should reflect the political and operational realities: that a State Party is in violation both of the APMBC and of international law. The notion of State responsibility means that a State should indeed be held responsible for its actions and its inaction. The current approach of the States Parties is to reward failure and willful inaction, hardly one that is conducive to encourage accountability and responsibility.

"Any ongoing mine clearance operation that does not locate a single mine (or other explosive threat) within ten days should ask itself whether it is working in the right place."

Second, the Implementation Support Unit (ISU) needs to up its game materially. The new director, recently appointed, should ensure that extension requests are not just checked for formalist and procedural issues, but also that the review assesses whether the data is robust and coherent, and that the associated plans are ambitious and evidence-based. One 2016 extension request that was on the cusp of being submitted, and which the ISU reviewed, contained an unacceptable number of logical blunders and glaring mathematical errors. To ensure this does not reoccur, States must support the ISU with the necessary financial, human, and technical resources and requisite mandate to enable the ISU to do its work professionally.

Third, oversight of demining programs in affected States Parties needs to be enhanced. This is a task for donor States and operational experts. It is time the cooperative duty to facilitate and clarify compliance under APMBC Article 8(1) is applied directly to operations. With the consent of the territorial State, a mission of experts is an informal mechanism and no threat to sovereignty; a State Party that has nothing to hide should seek to hide nothing. Every year two or three States, especially those imminently seeking an extension, could be assessed without significant financial outlay on anyone's part and then supported where necessary.

Fourth, it is a regrettable reality that while lip service is paid to land release, in many programs the risk-management processes inherent in the concept are, in the words of Hamlet, "more honor'd in the breach than in the observance." Although landmine impact survey methodology has received the last rites, the wilder estimates of massive, widespread contamination and devastating impact that it falsely generated still call to us from beyond the grave. Today, far too few States can proffer a rational estimate of contamination based on **confirmed** and not just **suspected** mined areas. This is even the case in States with demining programs that have been ongoing for two decades or longer. Investing in high-quality non-technical survey is a major operational requirement, not an optional extra.

From 28 November to 2 December 2016, States Parties and States not yet party to the APMBC will convene in Santiago, Chile, for the fifteenth meeting of the States Parties. Will it be business as usual? Another triumph of diplomatic form over operational substance? Or will States Parties finally grasp the mettle and resolve to make the Maputo Review Conference pledge of well-nigh completing global clearance by 2025 an operational reality?

See endnotes page 67

The author is editor of the Mine Action Review, *produced by Norwegian People's Aid, and honorary professor at the University of Pretoria's Faculty of Law. This article is written in an individual capacity.*

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FEATURE

MOBILE DATA COLLECTION: INTEROPERABILITY THROUGH NEW ARCHITECTURE

by Elisabeth Vinek, Sulaiman Mukahhal and Olivier Cottray
[Geneva International Centre for Humanitarian Demining]

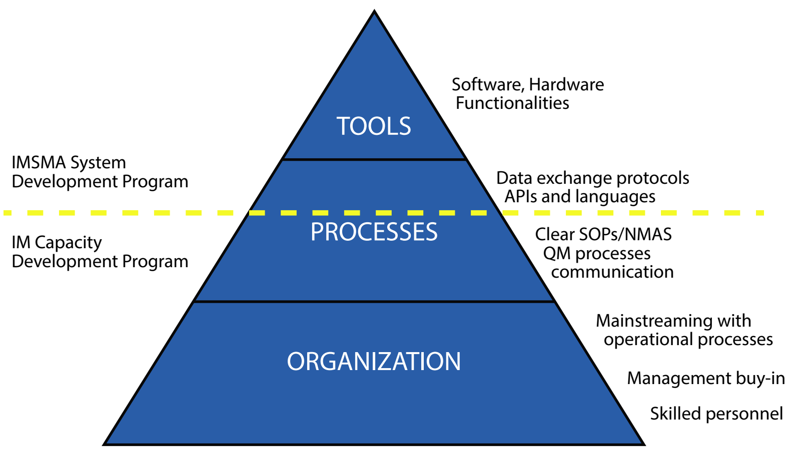

Figure 1. IM hierarchy of needs and GICHD information management support programs.
All graphics courtesy of GICHD.

Information management (IM) requires close collaboration between all parties in a mine action program and cannot be carried out in isolation. Effective IM involves tools as well as organizational processes that clearly define how different parties interact and function with IM. As depicted in Figure 1, without adequately defining processes through National Mine Action Standards (NMAS) and Standard Operating Procedures (SOP), even the most advanced and fit-for-purpose IM tools will lack the foundation to be effective.

Carefully integrating IM tools into the processes of an organization becomes increasingly important as more specialized tools become available. Recently, a number of applications were developed in the mine action community, many of them mobile data collection tools that address very specific requirements and needs.[1,2,3,4]

Mobile Collection Tools

The proliferation of mobile devices is increasing demand for mobile-based data collection solutions that bridge the information gaps in mine action programs. Operators and contractors in the field increasingly rely on mobile solutions to collect data about survey and clearance as well as other related activities.

The availability of easy-to-use software and development frameworks for common mobile platforms such as Android and iOS contributes to the proliferation of such tools. Designing a custom data collection form for a team being deployed to the field and making it available via mobile devices is a task that can be accomplished in a relatively short amount of time. Most tools can work offline and are able to synchronize data once an internet connection is reestablished.

The immediate benefit of using mobile data collection is real-time data sharing and analysis, and real-time tracking of deployed assets. It enables decision makers within mine action organizations to have quick access to information and make evidence-based decisions to implement and steer activities. Automatic georeferencing uses GPS functionalities built into devices and is another frequently mentioned benefit. Additionally, mobile data collection reduces the complexity of reporting by avoiding error-prone, double data entry (e.g., entering data via paper forms as well as manually entering data into a national information management system).

However, this synchronization with a central, national system presents a significant challenge. When different tools are used by various organizations to collect the same type of data, data is both stored in different locations, formats and technologies. In order to make informed decisions on a national level and preserve the data in the longer term, we must combine data into a single location. This requires robust data exchange mechanisms and standards.

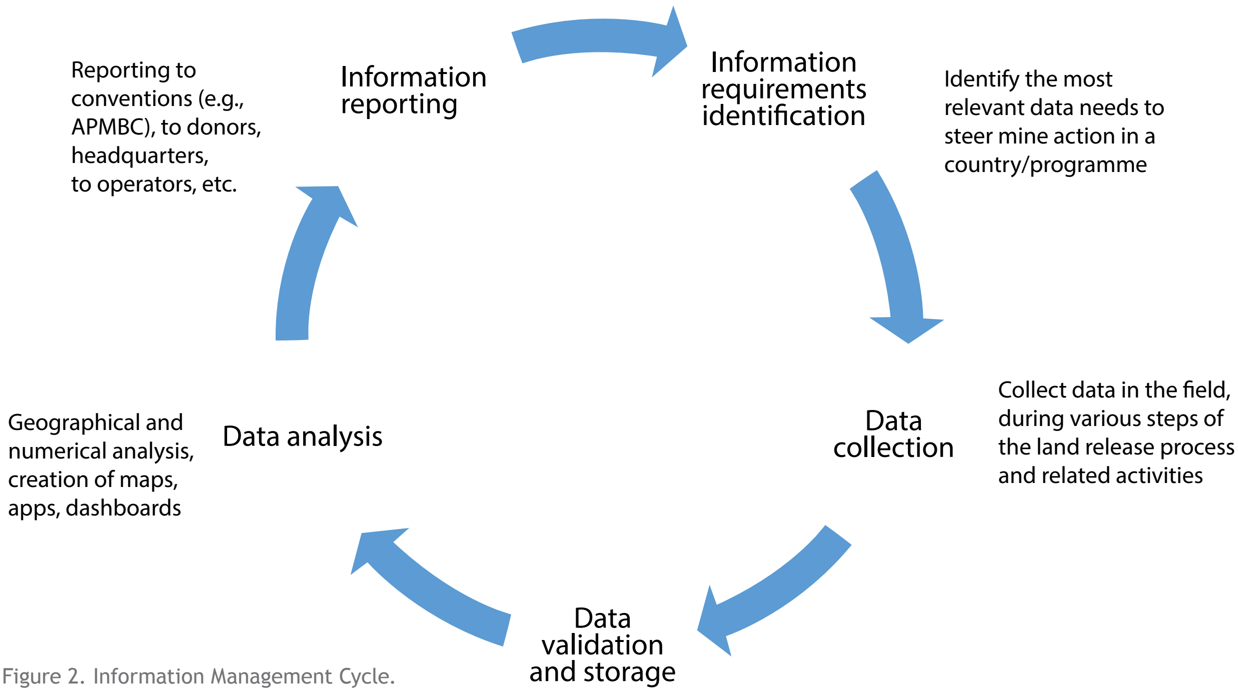

Figure 2. Information Management Cycle.

National Information Management Systems

As required by the national authority, many programs store country-wide mine action data in the Information Management System for Mine Action (IMSMA). Normally, data is collected by users in the field and sent to the national authority—either as paper reports, or digitally as Excel files or similar formats—and entered manually or imported into the central IMSMA database.

With so many different mobile data collection tools, there is an increased demand for a simple and robust data exchange functionality between said tools and IMSMA. One key element for data exchange is a common, well-documented data format that can be used to transfer data between two systems. For mine action, this requirement is addressed by the Mine Action Extensible Markup Language (maXML), which was originally developed in 2002 by identifying data that members of the mine action community are interested in sharing based on interviews and a review of various mine action information systems, standards and processes. It has been further developed since then by adding vocabulary that reflects the developments of the data that IMSMA contains. The maXML specification expresses these data as easily recognizable terms or words, and presents these terms in a structure that gives context to their meaning and intent. These terms and structure represent the maXML vocabulary. In most cases, the maXML vocabulary adheres to terminology used by the International Mine Action Standards (IMAS).

While the export and import of maXML are implemented within IMSMA, the current IMSMA^{NG} only partially addresses wider requirements for a seamless data exchange with third-party applications. In fact, national storage and validation of mine action data is only one step in the information management cycle (depicted in Figure 2) that IMSMA^{NG} must support.

The identification of information requirements—data collection, analysis and reporting—are addressed equally by the current IMSMA^{NG}. As it was originally conceived as a holistic tool, the ability to exchange data easily, while important, was not central to its design. Therefore no Application Programming Interface (API) is available to expose and leverage IMSMA business logic and functionality.

The emerging third-party applications mentioned previously cover specific steps of the information management cycle such as data collection via mobile devices or reporting through the Mine Action Intelligence Tool (MINT).[4] By focusing on one specific requirement, applications often outperform the **one-size-fits-all** IMSMA^{NG}, which must meet multiple requirements. Acknowledging these technological trends and new opportunities, GICHD initiated a new development cycle in 2015 focusing on IMSMA's role of data storage, validation and integration.

Motivation for Change

Regular updates to IMSMA are required in order to keep pace with evolutions in information technology. However, these updates also provide opportunities to rethink macro-level architecture and to take into account lessons learned from previous years, taking advantage of technological developments.

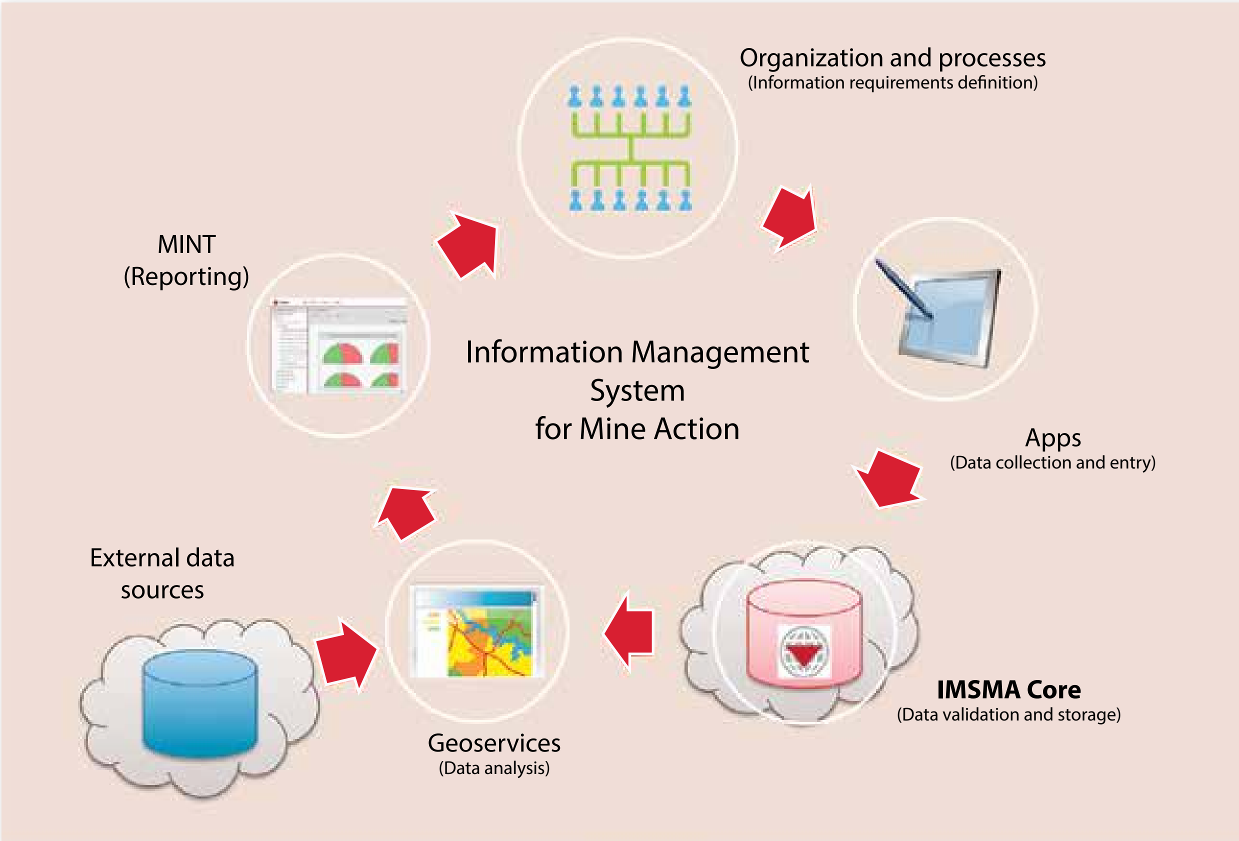

Figure 3. Vision of a future information management system for mine action.

With its adapted strategy and new development cycle, GICHD aims to address evolving and emerging requirements regarding user experience and interoperability with third-party applications. Moreover, GICHD will more efficiently employ off-the-shelf tools for mine action tasks. This will reduce costs and the need for specific technical system support, freeing up both GICHD and field IM resources to provide user-driven information products such as maps, reports and statistics.

In many programs, the core function of IMSMA is a platform to store and validate national data, while other functions such as data collection and analysis can be performed by specialized third-party applications. As a result, the current objective of the strategy is to strengthen this now-called **IMSMA Core** component and open it up for easy integration with data from a variety of sources. This will be achieved by defining an **IMSMA framework** including a revised maXML specification and an API allowing for seamless exchange of data and functionalities. In this sense, IMSMA should no longer be understood as a singular tool but as a system: a set of interrelated tools and processes that operate together to provide the sector with sound IM.

In IMSMA's new strategy, each step in the process can be carried out by a variety of standard or customized tools developed either by GICHD or by third-party developers provided these tools are interoperable, i.e., that they can communicate data between one another in a standardized and reliable manner. Figure 3 illustrates how this strategy supports all stages of the information management cycle. To accomplish this, GICHD will develop and maintain a robust mine action data exchange language—maXML and API—allowing for a standardized exchange of data and functionality between different tools in the system. In this way, GICHD seeks to foster and encourage an ecosystem of user-driven, interoperable, modular tools that can quickly leverage rapid advances in technology and more effectively put IM into the hands of mine action and relevant operational stakeholders.

The key objectives of the new IMSMA development strategy are

- To provide a common IMSMA framework under which a family of tools developed by different organizations for mine action can operate. This framework will provide an environment where different tools are compatible with IMSMA Core.

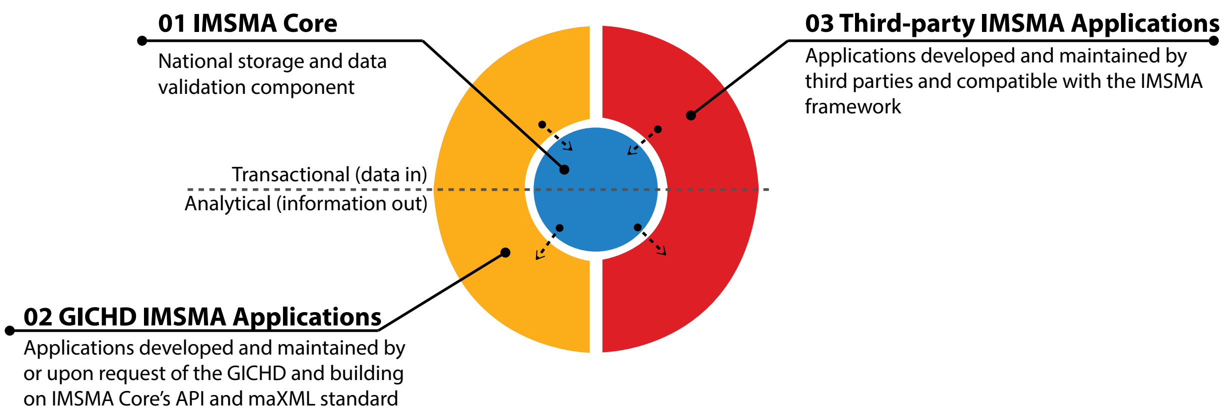

Figure 4. IMSMA applications.

- To design a data model that facilitates analysis of data through tools such as GIS and IMSMA MINT thereby contributing to more efficient planning of mine action operations and potentially other humanitarian sectors.
- To provide an IM system that is user friendly and requires minimal specialized training. This will free up GICHD's IM advisors to provide support on IM methods and will free up IM staff in partner organizations to focus on data analysis rather than technical issues.
- To facilitate easy and cost-efficient adaptation of IMSMA to evolving business processes.
- To reduce maintenance costs of custom-built tools in the future.

Implementation

While the development of IMSMA Core has only just started, the overall framework has taken shape, and tools for the various steps of the IM cycle have matured. Figure 4 specifies the vocabulary used for those applications, depending on their level of engagement with IMSMA.

- **IMSMA Core** refers to the central storage and data validation component with its data exchange functionalities.
- **GICHD IMSMA** applications refer to applications developed and maintained by or upon request of the GICHD and builds on IMSMA Core's API and the maXML standard.

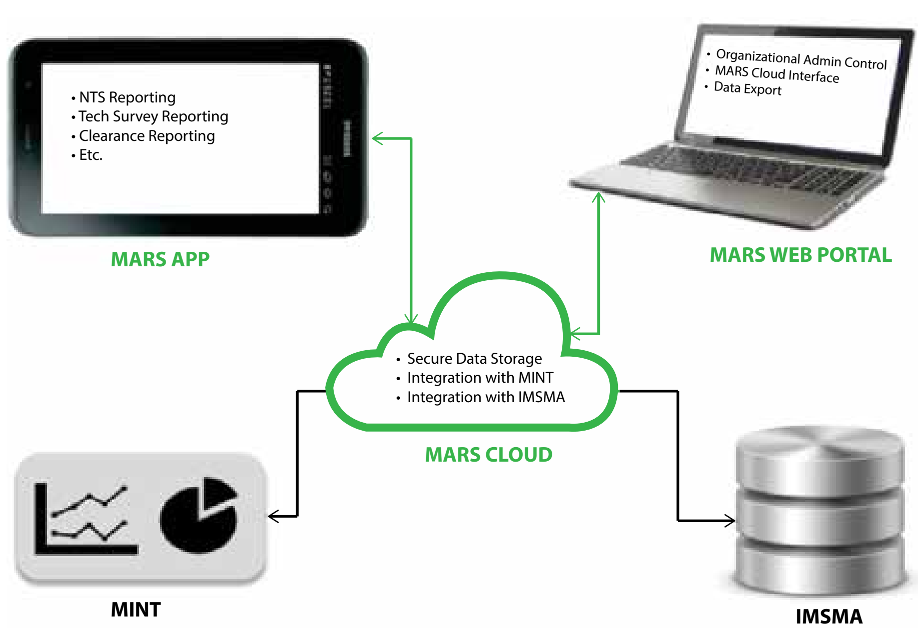

Figure 5. Overview of MARS.

- **Third-party IMSMA applications** refer to applications developed and maintained by third parties that are compatible with the IMSMA framework (i.e., they are able to exchange data with IMSMA Core and/or use the IMSMA Core API).

One example of a recently developed mobile data collection tool falling under the **IMSMA applications** category is the Mine Action Reporting System (MARS), which comprises three main parts:

- a field data entry mobile application (MARS Mobile)
- a web-based data management and administration portal (MARS Web)
- a cloud-based data storage (MARS Cloud).

After initial configuration via MARS Web, authorized users can collect data in the field using customized data entry forms or forms designed in IMSMA and imported into MARS. The mobile application allows GPS information to be captured as identifying points and polygons with a few finger taps. As soon as the mobile device is connected to the internet, the collected data is synchronized with the MARS Cloud and accessible for approval via the web portal. Finally, data collected via MARS can be imported into the IMSMA data repository and accessed via MINT for advanced data analysis and reporting purposes. As depicted in Figure 5, MARS is an example of an application integrated within the current status of the IMSMA framework and will be adapted as IMSMA Core and its API and data exchange capabilities mature.

Conclusion

The newly adopted IMSMA development strategy (2015–2018) aims at fostering better interoperability between the national storage component, IMSMA Core, and external applications such as mobile data collection. This interoperability will be achieved through an IMSMA framework that defines how various IM systems may interact. This development will take place in parallel to the maintenance and support of the current IMSMA^{NG} system that will continue beyond the development timeline of IMSMA Core.

See endnotes page 65

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Olivier Cottray joined the GICHD in January 2012, initially as the division's information services coordinator. As head of the information management division, he is now in charge of managing the team that provides information management capacity development and technical support to the mine action community. Prior to joining the GICHD, Cottray worked in humanitarian emergencies, running geographic information systems (GIS) support cells in U.N. and NGO field operations. Cottray completed a Bachelor of Science in geography and economics at the London School of Economics (U.K.) in 1998, and received a Master's in GIS and remote sensing from the University of Cambridge (U.K) in 1999.

FROM THE FIELD: MOBILE TECHNOLOGIES FOR MINE ACTION

by Torsten Vikström [Spinator AB]

T-IMS with Bluetooth connected GPS and binocular rangefinder.
All photos courtesy of © Spinator AB.

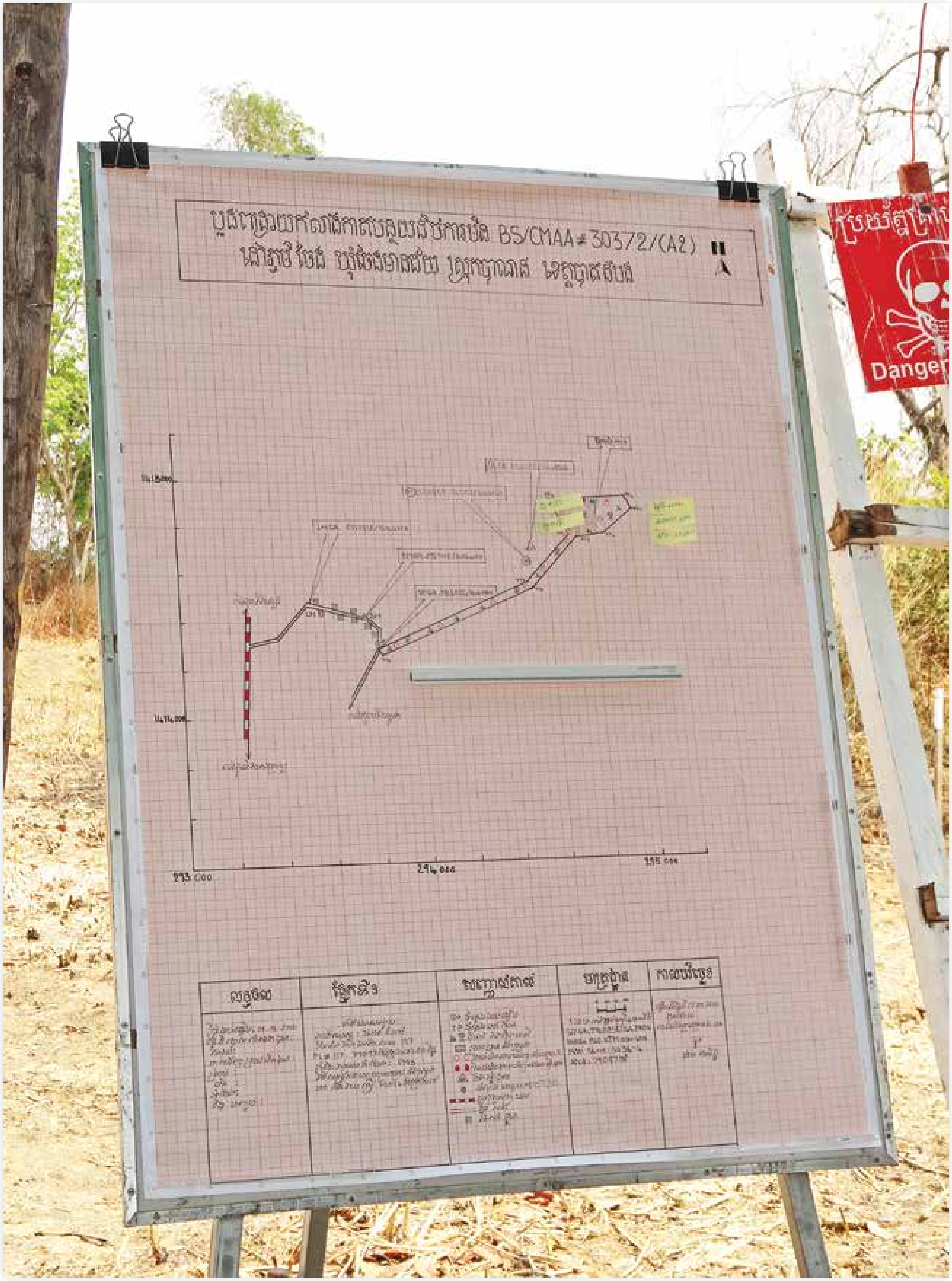
Breakthroughs in technology development transformed desktop computers into small, powerful mobile units equipped with intelligent software and extensive possibilities to connect and interact. Alternatively, the world of mine action still depends on manual work done with pen and paper, and the process of field data collection is especially exposed. However, field tests show that the use of mobile technology vastly improves safety and increases the effectiveness of field work. Adapting to new mobile technologies for field data collection will also positively affect the ways in which we gather, share, analyze, monitor and evaluate information.

TIRAMISU

Through the TIRAMISU project, the European Union assumed the task of boosting clearance efforts in countries plagued by war and conflict.[1] This project, which received funding from the European Union's Seventh Framework Programme (FP7) for research, technology development and demonstration under grant agreement n° 284747, has engaged 26 partners from 12 countries.

The objective of the TIRAMISU project is to provide the mine action community with a toolbox to assist in addressing the many issues related to humanitarian demining, thus promoting peace, national and regional security, conflict prevention, social and economic rehabilitation and post-conflict reconstruction.

One outcome of this project is the TIRAMISU Information Management System (T-IMS), a mobile field data collection tool for humanitarian demining. T-IMS is a software application for deminers and surveyors in the field. GIS centric, the app is built for touch technology and functions without the need for a keyboard or mouse.[2,3] Emphasis was placed on the "ease-of-use" aspect, which means system data and



A hand-drawn map containing critical information. Is this the best we can do?

13

Briefing in the tent at the benchmark of minefield #06926 by a CMAC team leader before entering the minefield.

information from the field can easily be captured. This includes the ability to mark suspected and confirmed hazardous areas (SHA/CHA); map sketches; identify and locate landmines, unexploded ordnance (UXO) and other findings; take geo-referenced photos, videos and interviews with voice recordings; use GPS tracking and more. The system supports non-technical survey (NTS), technical survey (TS), mine/UXO clearance, quality assurance (QA), quality control (QC), and structured reporting and analyses. It does not require an internet connection and is fully functional offline. Furthermore, T-IMS optionally contains the Collaborative ORDnance Data Repository (CORD), designed and developed by Ripple Design and Mindlark, and hosted and managed by the Center for International Stabilization and Recovery (CISR) at James Madison University (JMU).[4] CORD provides access to approximately 5,000 ordnance objects offline.

As incorporating standards are of great importance, the system is compliant with the Mine Action Extensible Markup Language (maXML), a data specification integration standard, which can exchange information with the Information Management System for Mine Action (IMSMA), developed by the Geneva International Centre for Humanitarian Demining (GICHD).[5] The system also uses standardized map symbology for mine action to avoid the misinterpretation of sensitive information.[6]

Operational Validation in Croatia

In 2015, T-IMS was validated by the Croatian Mine Action Centre (CROMAC), whose team was authorized to validate TIRAMISU tools.[7] During validation, T-IMS was tested for several months in field survey operations by CROMAC deminers and surveyors. CROMAC survey experts provided the basis for the validation procedure. CROMAC's validation team concluded that T-IMS

- Enables precise collection of geospatial data in the field and can store the collected data in the information management system (IMS).
- Improves the general survey processes and SHA analyses by allowing information collected in the field to be directly transferred into the IMS. This reduces the time needed to update the IMS and expedites decision making and prioritization processes.
- Improves the safety of field activities by recording surveyor and geospatial positioning.

Cambodia Field Experience: Battambang Province

With a long history of war and conflict, Cambodia is still one of the most contaminated countries in the world. In northwestern Cambodia, the Battambang province has had more landmine casualties than any other province in the country. Between 2005 and 2007, a total of 2,588 accidents

Ordnance objects identified with CORD in the T-IMS ordnance module.

were reported in the Battambang province.[8] Ten years later, landmines still cause injury and death.

In March 2016, the author visited Cambodia with GICHD to field test T-IMS. Conducted together with the Cambodian Mine Action and Victim Assistance Authority (CMAA), the evaluation took place in three different minefields in the Banan district of Battambang province, where the Cambodian Mine Action Centre (CMAC) was conducting clearance operations. The system was used for NTS, TS, QA and QC activities on these operational sites.

For the field tests, the team loaded overview maps of the area from OpenStreetMap into the map module and equipped the system with the ordnance database CORD for offline use.[9] Small, Bluetooth-compatible handheld GPS devices were also included to show the current position of the user in the map module.

During NTS and TS, the team documented all three minefields directly into the system. SHAs and CHAs were plotted directly into the map module. The turning points (i.e., fixed points on the ground that indicate a change in direction of the perimeter) of these areas had longitudinal and latitudinal values previously recorded by CMAC and were thus entered into T-IMS to create SHAs and CHAs.[6] The team drew boundaries and safe points, documented and positioned benchmarks in the T-IMS map module (i.e., reference points that indicate hazards or hazardous areas outside the SHA or CHA), and identified landmines via CORD (e.g., PMN-2, POMZ-2 and Type 72).[6] Geo-referenced photos and videos were recorded, and GPS tracking was enabled to capture the team's (safe) route through the minefields. The system documented clearance priorities and the progress of the survey and clearance activities to create a snapshot of the current situation as of area cancelled, area cleared, and area reduced following the process of land release.

The system also documented QA/QC activities on the largest minefield (457,000 square meters or 546,567 square yards). During QA/QC activities, the team used the NTS and TS tools as well as the quality management tools with standardized QA/QC input forms to make additional voice recordings, take videos and photos, interact with the map, perform GPS tracking and use the ordnance module CORD to strengthen the QA/QC reports. Documentation of the three minefields occured directly in the field without any modifications or additional office work. Each report took an estimated 15 to 30 minutes to complete.

The surveyors, clearance personnel, QA/QC and management staff of both CMAA and CMAC appreciated the simplicity of T-IMS in both usage and information collection; the GPS connectivity, which displayed actual positions in the field and simultaneously used GPS to add and draw points, lines, and polygons; and the access to an offline ordnance database, which gives instant access to approximately 5,000 ordnance objects such as landmines and types of UXO.

Offline Ordnance Database

During field activities, having direct and instantaneous access to an offline ordnance database (such as CORD) as a part of a mobile field data collection tool is of great value for surveyors and clearance personnel. Facilitating risk assessment and situation awareness, offline ordnance databases provide improved security for those involved in operational activities. Statistics and geographical information on mines and UXO

Inspection of an area cleared by a machine as part of the QA activity.

from past clearance operations can improve decision making for clearance personnel planning in nearby regions.

Conclusion

In addition to being easy to use, GIS-based mobile tools must also support the global processes of humanitarian mine action by allowing data to be collected, stored and reported in a standardized manner. Once information is automatically processed from surveyors' or deminers' work in the field—including recorded interviews, geo-referenced photos, drawings of CHAs, plotted GPS tracks—and inserted into the information management system (e.g., IMSMA), where it is collected for further processing, aggregation, analyses and sharing, only then will we see the true benefits of mobile technology in the field.

See endnotes page 65

The author wishes to thank the European Commission and HCR-CTRO (CROMAC-CTD) as well as Mikael Bold for his support and comments on the draft.

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FEATURE

MOBILE TECHNOLOGY IN MINE ACTION: THE FULCRUM APPLICATION

by Camille Wallen and Nick Torbet [The HALO Trust]

HALO staff in Cambodia receive training in Fulcrum.
All photos courtesy of The HALO Trust.

In 2014, The HALO Trust (HALO) began trialing Fulcrum, a mobile data collection application for survey developed by Fulcrum Mobile Solutions. Due to the success of the trial, the subscription-based commercial product, designed specifically for mobile data collection, was used in eight HALO programs. Using Fulcrum, HALO has created 35 applications that collect data for a variety of outputs, including rapid contamination assessments, socioeconomic and impact surveys, minefield quality assurance checks, vehicle and logistics checks, and a number of reports including technical and nontechnical surveys, explosive ordnance disposal (EOD), mine risk education (MRE), and daily minefield stats reports.

Enhancing Data Collection and Analysis

The principal benefit of Fulcrum is more efficient and accurate data collection. Prior to using the app, HALO's Cambodia program alone generated over 3,000 pages of paper reports every month, all of which were entered manually into an internal operations database and the national International Management System for Mine Action (IMSMA) database.

Since HALO introduced Fulcrum in its Cambodia program, the data entry workload has reduced by over 70 percent. Survey teams, MRE teams and supervisors now all carry Android tablets and use dual-language apps in Khmer and English created in Fulcrum. Each tablet has access to multiple applications for teams that require several different types of forms. In the field, data entered directly into the tablet can be exported to HALO's in-country database and converted into Extensible Markup Language (XML) format for submission to the national IMSMA database. The huge reduction in manual data entry means that the program information management team can spend more time checking the quality of data and providing analysis. The system is also cost-effective, the increasing availability of high-quality mobile devices and low subscription costs are met by increases in efficiency and the ability to scale up the system without putting significant strain on resources.

Using mobile technologies such as Fulcrum also enables the real-time management of teams in the field. Issues on the ground can be resolved immediately without the need to return to headquarters for problems to be identified and handled at a later time. This has particular pertinence in insecure environments such as Syria and remote locations such as Laos.

Personnel do not need to be IT experts to use the application. New applications such as survey forms can be created online in a matter of minutes, with little to no training required. To prevent data corruption or user errors, each device has a unique username. All input data is associated with specific devices and different levels of access are granted to administrators and users. The simplicity of setting up apps, exporting data and analyzing the results also means that one-off studies can be conducted, assessments are rolled out rapidly and survey forms can be edited remotely when required, taking the burden off resource-intensive and time-consuming tasks. Moreover, the Fulcrum software developers are very responsive to adding new functions to the system in response to requests from users such as HALO, enabling more advanced applications to be developed using the same simple tools.

Notably, the use of mobile technology has increased the efficiency of socioeconomic surveys conducted pre- and post-clearance. The detail of these surveys in paper form can create problems with time-consuming data entry, more opportunities for data entry errors and complex databases that are difficult to manage and analyze. Fulcrum has significantly enhanced the capacity of HALO's community liaison and survey teams conducting this work, reducing the time required to conduct interviews, removing the requirement for separate data entry and enabling data to be exported and results to be analyzed remotely in HALO's global headquarters.

A HALO team leader and operations officer in Laos enter data in the field during technical survey.

Challenges of Mobile Technology

While mobile technologies bring many benefits and present multiple opportunities, they still present challenges, particularly in less developed countries. Tablets and smartphones require accessible data networks in order to upload reports. As teams can spend weeks at a time out in the field without access to a mobile data network or Wi-Fi, they are often unable to upload their collected data. While mobile devices are able to store and collect data offline, Fulcrum can only back up to its cloud-based database, which requires internet access. If devices are unable to connect to a network, teams run the risk of losing any data that has not been uploaded were anything to happen to the device. Therefore, while HALO is exploring alternative solutions to backup data from Fulcrum in countries where data networks are poor or non-existent, pen and paper remains the primary collection method to avoid any large loss of data, time and work. While pen and paper and Fulcrum are sometimes used in conjunction with one another, the former is preferred for minefield survey reports whereas the latter is currently used for socioeconomic survey. This remains the largest restriction to the use of mobile technology in HALO programs.

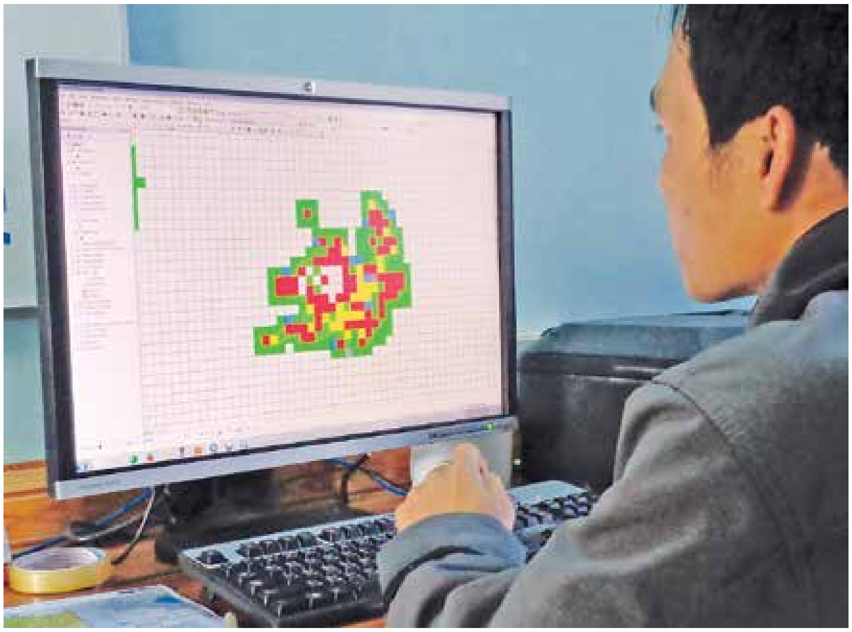
Exporting data from Fulcrum is easy; however, integrating the Fulcrum data into existing program databases can be more challenging, requiring time and attention from database and GIS managers to ensure the data synchronizes correctly. Although not all Fulcrum users (teams, supervisors, etc.) require advanced IT skills or knowledge of HALO's program databases, using remote technology can be challenging for those who have very little IT experience. Using smartphones can help to familiarize staff members with the technology, but additional training may be required for those who have no prior experience with the technology before they feel comfortable and are proficient at using it in their daily work.

Similarly, communities who are unfamiliar with smartphones or tablets may at first be suspicious of the technology during survey or interviews and may be unwilling to participate. It is therefore important to recognize where such an issue may occur and to mitigate any negative effects through community demonstrations or by using alternative methods that are familiar to the community.

Potential of Mobile Technology

Despite these challenges, mobile technologies can significantly enhance the efficiency, effectiveness and accuracy of data collection. Applications such as Fulcrum can also be used to manage emergency situations remotely. By including photos and videos in reports on new item types that were recently found, field personnel can relay information to specialists in real-time, who can provide technical recommendations to the field team remotely.

Mobile technology has a role to play in mine action operations, and the ongoing development of systems such as Fulcrum enhances the capacity of operators in their everyday



A HALO Laos geographic information system specialist uses data sent from the field to map areas contaminated with submunitions.

activities. HALO's most advanced use of Fulcrum is in Laos, where it is used to assist with efforts to survey and clear UXO (unexploded ordnance) contamination.

Case Study: HALO's Use of Fulcrum in Laos

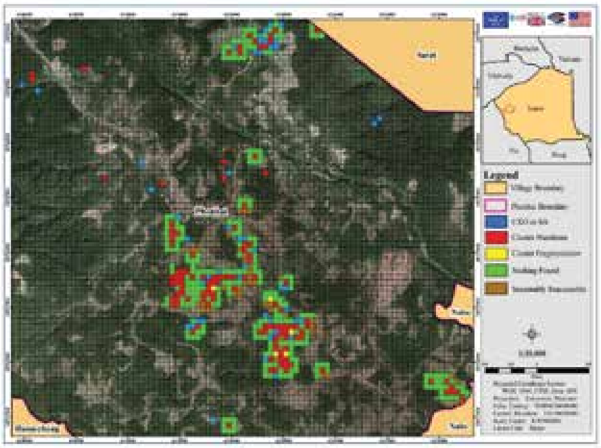
Laos remains heavily contaminated with UXO (particularly air-dropped submunitions) from the Indochina wars. Even 40 years after the conflict, UXO continues to impact some of the most impoverished and isolated communities. Estimating the scale of the problem and mapping the extent of contamination has proven to be particularly challenging. HALO is working alongside other operators to both define and survey the extent of the submunition contamination as well as clear it.

Much of the challenge can be attributed to the technical nature of air-dropped cluster munitions, which distinguishes Laos from other demining programs. Submunitions were dispersed from aircraft and, in the vast majority of cases, were intended to function upon impact with the ground. The residual submunitions are those that failed to function as intended, which present unique survey challenges; the dispersal pattern of submunition strikes is far more varied and widespread than minefields, and records of their locations are far less precise. Even with local knowledge of contaminated areas, assessing and mapping submunition strikes for clearance is hugely challenging. Conversely, it also presents opportunities. Submunitions enable survey teams to enter a contaminated area physically and use hand-held metal detectors to confirm the extent of the contamination. This enables operational management to very accurately target follow-on clearance operations.

This technical survey process is fast-paced and data heavy. Any locally reported submunition is known as an evidence point, and HALO's GIS department overlays the surrounding area with a universal transverse Mercator (UTM) grid, divided into 2,500 square meter boxes (50 x 50 m), a method introduced by Norwegian People's Aid (NPA) in Laos as described in an article in *The Journal of ERW and Mine Action*, issue 17.2.[1] Using MBTiles (mapping software that allows users to load map layers onto mobile devices for offline use), each box is assigned a unique ID, and survey teams search the boxes surrounding each evidence point, recording the locations of any identified submunitions. The intent of the survey team is not to identify all submunitions within a single 50 x 50 m box, but only to determine if there is further evidence of contamination. In practice this usually means marking and destroying the first identified submunitions in a box before moving on to surrounding boxes.

Given the extent of the bombing campaign, each box contains a large amount of information (UXO identified, UTM locations, date searched, etc.), which needs to be centrally stored and monitored. Transferring this data by paper is time consuming and prone to human error. Data must be recorded by hand, called into the GIS department by phone or hand delivered and then manually entered into the operational database. This is at best hugely inefficient and at worse unsustainable, given the scale of the task faced by in-country clearance operators. The problem is compounded when multiple strikes overlap one another, creating added complexities as survey officers have to contend with different strikes in close proximity that may require the survey of additional boxes. The use of the Fulcrum system means that teams can now reconcile all issues with a single visit rather than needing to revisit a single area multiple times in order to clarify outstanding queries.

Consequently, HALO has equipped all of its Laos survey teams with Samsung Tab4 tablets loaded with the Fulcrum app and connected to the country's effective 3G network. HALO selected the Tab4 for its availability, price, and durability, although any mobile devices running Android or iOS



An example of contamination mapping in Phonhai village, Laos, showing results of the technical survey.

are suitable. Using Fulcrum, HALO's operational management team created several different forms, enabling the easy and accurate collection of data—ranging from socioeconomic information about impacted communities to EOD reports detailing the location of destroyed UXO. The app is user friendly, and the team can design and edit forms without requiring any significant technical knowledge. This flexibility allows HALO to ensure accurate and comprehensive data reporting.

The Tab4 has proven to be remarkably durable during field operations, surviving months of rain during wet season operations and constant use in jungle terrain. While there are occasional 3G coverage limitations, each team is able to synchronize their data with headquarters daily, and in many cases, they are able to live stream data. All data gathered during the survey process is downloaded as a Microsoft Excel file format and automatically entered into HALO's Microsoft Access operational database. Links with the program's GIS software (ArcGIS Desktop) then enables a visual representation of this data and by assigning a color code to each box (e.g., green for no cluster munitions found, red for found cluster munitions), operations management can then identify confirmed hazardous areas (CHA) that can be entered into HALO's work plan and national database.

Aside from the requirement for 3G coverage, some key lessons have been identified. First, when designing digital forms, it is important to minimize the amount of free-text data entry as possible, usually through the use of drop down menus. This hugely reduces problems associated with maintaining consistent database records that are also symptomatic of paper reports, such as changes in spaces, numbers or capital letters (e.g., variations on 105 millimeter artillery shells can include: 105, 105 MM, 105 millimeter, and 105 mm). Second, the GPS technology within mobile devices is often not accurate enough for UXO survey purposes. Currently, separate data is manually entered into forms from more accurate Garmin GPS, but in the future HALO will look to GPS linked directly to the Tab4 via Bluetooth.

Cluster munition technical survey is intensely data driven, and GIS is a crucial component of the whole system. This mobile technology has revolutionized HALO's approach to UXO surveying in Laos, switching from paper maps and forms to integrated software that enables straight-forward data entry and visual representation. HALO is investigating what other support and management systems could be streamlined through the use of mobile data collection. In the near future, HALO Laos hopes to use apps such as Fulcrum to eliminate all paper reporting completely, enabling operational teams to record all of their daily statistics and synchronize immediately with headquarters.

See endnotes page 65

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Camille Wallen is HALO's global monitoring and evaluation manager. She oversees monitoring and evaluation (M&E) across all HALO programs, including the design and implementation of M&E systems, socioeconomic surveys and impact studies, through which she has helped to develop HALO's use of mobile technology in M&E. She is based in Washington D.C., though frequently travels around HALO's programs.

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MOBILE TECHNOLOGIES: UXO LAO'S EASY SKETCH MAP

by Hayashi Ontoku Akihito [JICA adviser to UXO Lao]

Established in 1996, the Lao National Unexploded Ordnance Programme (UXO Lao) promotes risk education and clears land for agriculture, community purposes (e.g., schools, hospitals, temples and water supplies) and other development activities. UXO Lao is working in the nine most impacted Lao provinces nationwide. Although recent changes occurred to UXO Lao's survey procedure, the program continues mapping out contaminated areas throughout the country.

Introduced in 2013, a new mobile technology altered survey operations to produce accurate maps for clearance work. In the past, organizations created maps by hand, which may have resulted in the production of less accurate maps. Moreover, the process of developing a map required time and multiple team members. The newly introduced application, which works on an Android tablet, makes the operation faster and more accurate.

Past Operations

Before clearance could begin, UXO Lao's procedure required the use of a sketch map for each clearance site. Initially, a four-member general survey team began by hand drawing a sketch map, which was time-consuming. A team would visit a site before clearance and use GPS to measure latitude and longitude, a compass for bearing between two turning points, and tape to measure distance between those turning points. A team member wrote down all necessary information and brought this back

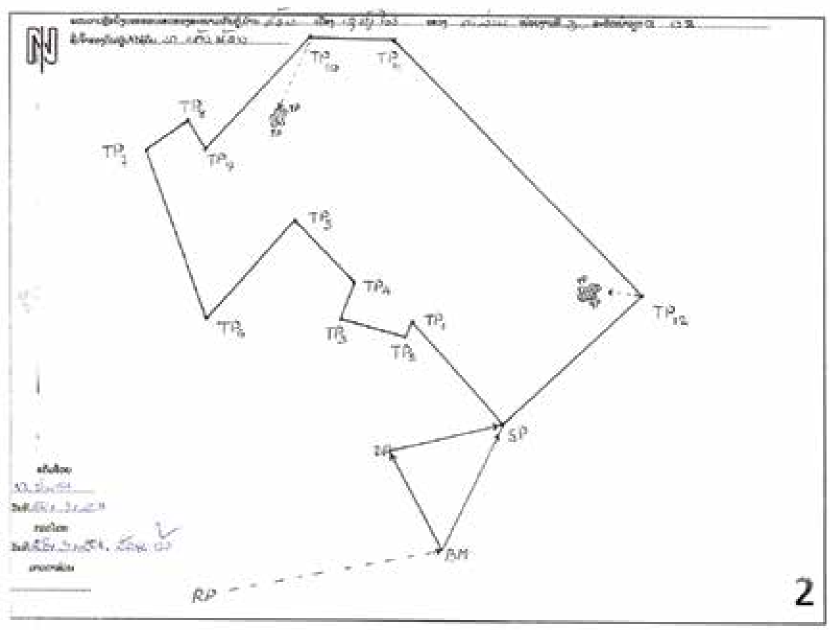

Figure 1. UXO Lao's procedure requires the use of a sketch map for each clearance site before beginning clearance.
All figures courtesy of the author.

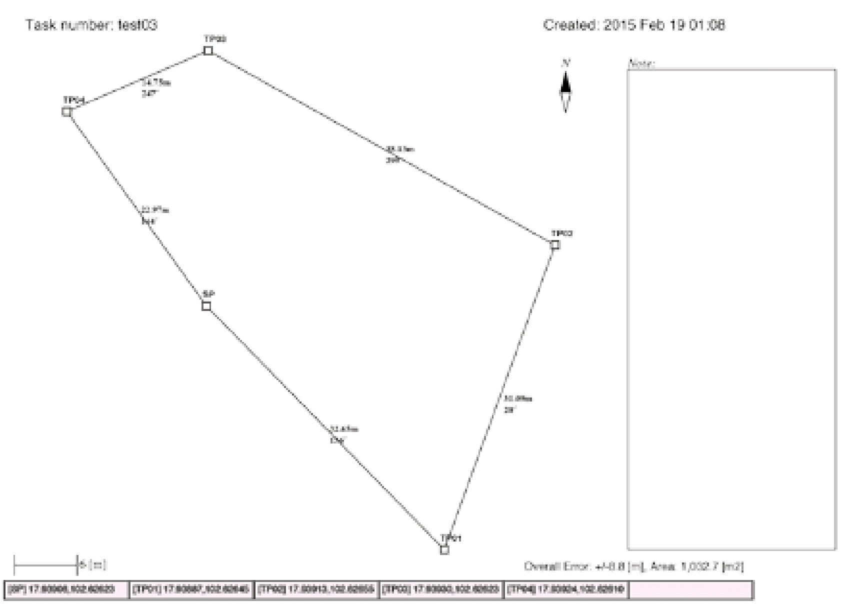

Figure 2. The Easy Sketch Map mobile application enables survey teams to create sketch maps more efficiently.

to the office, where the team continued working on the sketch map by calculating the size of the clearance site (see Figure 1). Used by UXO Lao in the past, this procedure required one to two hours to obtain all the necessary information at the site. In addition, creating a handwritten sketch map took the team another two to three hours.

Impact of Easy Sketch Map

The Easy Sketch Map application significantly altered the procedures of general survey operations, enabling the survey teams to create a sketch map faster and with less effort. With this application, a staff member from a general survey team walks along the boundary of a clearance site with a tablet and clicks a button at each boundary turning point. After recoding all of the turning points, the application automatically produces a sketch map in portable document format (PDF) file, which the team can easily share and print out (see Figure 2).

This application reduces the workload of the general survey teams in two ways. First, the amount of time required to produce a map is reduced, because going through the manual process of creating a sketch map is no longer needed. Second, fewer team members are required. In the past, four staff members of a general survey team had to work at the site, whereas one staff member can produce a map using the application.

During the trial phase, a general survey team in a province produced a report comparing the old and new methods. They compared the accuracy of latitude and longitude, distance, bearing and the land size in respective methods. The result showed that the application met UXO Lao's requirements and concluded that the application was capable of producing a map with the same accuracy as the old processes with less effort.

Technical Features

Apart from the practical function, the application has a number of technical features:

- The application can run on GPS-enabled tablets and smartphones equipped with Android 4.0 or above.
- Latitude is automatically corrected when determining the distance between turning points. The distance varies depending on latitude even if the points are on the same longitude.
- Red, yellow and green lights indicate the accuracy of the GPS. A user clicks the recording button when the light turns green, ensuring the recording is accurate.
- The application produces a PDF file in vector graphics, so that lines and fonts are smooth and may be enlarged for displays and printed materials.
- The application produces a comma separated value (CSV) file of the recorded data, and can record and store multiple tasks.

The files are versatile in that the CSV format can be converted to keyhole markup language, which is accessible through Google Earth. This technical feature makes clearance site data accessible in multiple ways.

Instructors in the IT department at the National University of Lao developed the Easy Sketch Map application in 2013 with support from the technical cooperation project on IT, supported by Japan International Cooperation Agency (JICA). UXO Lao provided the information for the development of the application, and the instructors contributed to its development. Japanese advisers took the lead during the initial stages in order to define the specific requirements of UXO Lao, but Lao instructors developed the actual application. Thus, repair and maintenance of the application can be done locally, which is another advantage of the Easy Sketch Map application.

In 2015, general survey teams were renamed as non-technical survey (NTS) teams, which have different functions from the general survey operation. Accordingly, the application's functions need to be reviewed to meet the NTS teams' needs.

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In the Spotlight

SOUTH & CENTRAL ASIA

Integrated Cooperation on Explosive Hazards Program in Central Asia

by Luka Buhin [OSCE Office in Tajikistan]

The Organization for Security and Cooperation in Europe (OSCE) Office in Tajikistan (OiT) facilitates regional cooperation and coordination in the field of mine action in Central Asia, predominantly focusing on but not limited to inter-military cooperation. This approach falls under the OSCE concept of comprehensive and cooperative security. One of the best examples of this cooperation is the OSCE extra-budgetary project, the Integrated Cooperation on Explosive Hazards Programme (ICExH), which has been running since mid-2013. The project received financial support from the governments of Austria and the Netherlands in the past, while the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) has provided funding since 2014.

OSCE developed the project in an effort to improve the explosive hazards situation in Central Asia as well as in Afghanistan.[1] This encompasses issues related to explosive ordnance disposal (EOD) and includes demilitarization of explosive ordnance and countering improvised explosive devices (IED).

Figure 1. Map of Central Asia.
Figure courtesy of OSCE/Umed Egamberdiev.

Building Confidence in Central Asia

Although the scale and threat of explosives hazards vary in Central Asia, the governments, military forces and humanitarian demining organizations face similar challenges—from the illicit use of abandoned or uncontrolled explosives, unsafe storage and transportation of munitions, to inadequate investment in the life management of serviceable ammunition.

A series of unplanned explosions at munitions sites in Central Asia during the 2000s— and particularly in Abadan, Turkmenistan, on 7 July 2011—demonstrated that the regional explosive hazards problem was a broader threat than those covered by the traditional framework of mine action, and included the illicit use of abandoned and uncontrolled explosives and the unsafe storage and transportation of munitions. Thus in early 2012, the OSCE OiT's emphasis changed from a top-down regional coordination of mine action in Central Asia to a bottom-up approach via EOD, risk education and management trainings, conventional ammunition destruction, stockpile security, stockpile management, and the encouragement of regional technical dialogues during exchange visits. This important change in emphasis helped shape the design of the activities, outputs and intended outcomes of the ICExH project.

Understanding the Context

Developing regional projects demands an in-depth understanding of the context in which the project was initially developed and subsequently implemented. This was explicitly underlined in the external mid-term evaluation of the project.[2]

A number of factors affected the initial ICExH project:

- An absence of commonly accepted international norms and agreements related to conventional weapons destruction and humanitarian mine action.
- An absence of regional political consensus combined with a lack of enthusiasm to cooperate on regional security issues, as well as the perceived threat that cross-border and/or regional cooperation, even on a technical level, may have significant political implications.
- Discrepancies between the expressed political will of countries in the region and poor implementation of stated intentions on the ground. This fact is also reflected on a country level where a hierarchical and formalized decision-making and decision-implementing system is practiced.
- Discrepancies in understanding mine action (including its components), since not all of the countries have

Tajik and Afghan students share their experiences with EOD operations in Dushanbe, Tajikistan (November 2015).
Photo courtesy of OSCE/Nozim Kalandarov.

An explosive hazards awareness instructor from DanChurchAid (DCA) in Dushanbe, Tajikistan, with students from Kyrgyz, Tajik and Turkmen Ministries of Defence (March 2015).
Photo courtesy of OSCE/Nozim Kalandarov.

established mine action programs. Consequently, programs differ between countries, i.e., from a predominately militarized approach to a mixed involvement of civilian, military and law enforcement agencies.

The challenging political-military situation in Afghanistan and elsewhere in Central Asia means that establishing and sustaining regional cooperation is difficult. Studies of cross-border cooperation efforts in Central Asia show that effective regional cooperation takes time to develop and requires gradual implementation.[3] The ICExH project's initial efforts to establish a regional mine action body to coordinate personnel and resources in Central Asia from the top-down were eventually abandoned in favor of focusing on tangible technical-level cooperation.

Building National and Regional Capacities

Until recently, military forces predominately handled explosive hazard reduction and response tasks in Central Asia. The military capabilities in Central Asia are influenced by former Soviet military doctrine. In many instances, the military units' demining procedures more closely resemble minefield breaching used in wartime than humanitarian demining deployed in peacetime. Similarly, the standards used to store, transport and destroy munitions and other explosives fall short of today's international peacetime norms.

However, there are positive aspects to this. First, the States in the region are responding to explosive hazards challenges with their own military forces, although the presence of international actors is required to a limited extent. Second, the development of demining and EOD capacities is clearly driven by the needs of military and security forces as well as the agenda of regional nations that wish to participate in U.N. peacekeeping operations requiring these capacities.

In the development phase of the ICExH project, a particular challenge was to identify the common denominator of explosive hazards challenges in relation to national and regional capacities. The project uses a decentralized approach in providing capacity-building opportunities via the Tajik and Kazakh Ministries of Defence as key national partners. In conjunction with the Tajikistan National Mine Action Centre (TNMAC), the Tajik Ministry of Defence already possesses capacities and experiences in mine action, including EOD. Similarly, the Kazakh Ministry has a well-established explosive ordnance demilitarization program. Both of these allow the ICExH project to anchor the training programs within the existing structure(s) and/or future training school(s).

A Tajik junior instructor, under mentorship of USARCENT, demonstrates subsurface clearance procedures during a battle area clearance operation to Armenian, Kazakh, Kyrgyz and Tajik students in Lyaur, Tajikistan (April 2016).
Photo courtesy of OSCE/Nozim Kalandarov.

ICExH Project

The key objective of the ICExH project is to provide targeted capacity development and technical assistance in responding to explosive hazards. This is done through IMAS compliant trainings focused on training instructors, exchanging information and shared best practices, and developing regional training institutions. The ICExH project is also designed to foster dialogue by providing a platform where mine action professionals in Central Asia are exposed to contemporary EOD, risk education and training management practices, which includes international standards and operating procedures.

During the initial ICExH project training cycle from 2014 to 2015, over 70 specialists from Afghanistan, Armenia, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan attended EOD level 1 through 3+ (IED disposal and explosive ordnance demilitarization) and risk education courses. The EOD trainings were delivered in Dari, Russian and Tajik. The ICExH project's second training cycle, which commenced in 2016, introduced Central Asian junior instructors to support the course's delivery. Eight junior instructors from Afghanistan, Kazakhstan, Kyrgyzstan and Tajikistan in conjunction with senior instructors from the United States Army Central (USARCENT) delivered EOD level 1 and level 2 courses in April 2016.

In total, 55 civilian and military professionals from Central Asian States and Afghanistan traveled to Tajikistan (August 2013) and Bosnia and Herzegovina (November 2015). Furthermore, the ICExH project webpage was developed and is regularly updated to support networking and information sharing. The web page (www.osce-icexh.org/index.php/en) is available in English, Russian and Tajik.

At the project's inception, the Tajik Ministry of Defence agreed to host a regional training program managed by the OSCE OiT. Additionally, the Ministry committed to establishing the Regional Explosive Hazards Training Centre, which will host IMAS-compliant national and regional courses in explosive hazard reduction and response. During the summer of 2014, trainings were held in two locations: the Engineering Demining Regiment in Dushanbe and the Field Training Centre of the Military Institute in Lyaur. Additional construction for a new, self-sufficient training center is planned to begin in late 2016. Moreover, with a signed tripartite memorandum of understanding (MoU) between the Kazakh Ministry of Defence, OSCE Office in Astana and the OSCE

A USARCENT instructor evaluates student performances during the student-led lessons on the EOD level 3 course in Dushanbe, Tajikistan (July 2015).
Photo courtesy of OSCE/Nozim Kalandarov.

OiT, organizers can begin planning for the regional EOD level 3+ demilitarization manager's training in 2016 and 2017.

Partnerships Nexus

On average, between 30 and 40 governmental ministries and agencies, foreign embassies, and national and international organizations from at least eight countries are engaged in the execution of a regional training course in Dari, Russian and Tajik.

USARCENT is the main training partner for the ICExH project. In addition to providing and delivering EOD courses level 1 through 3+ (IED awareness and disposal), USARCENT provided training ordnance and aids to the future regional training center of the Tajik Ministry of Defence. The explosive hazard awareness and reduction pilot course implemented in March 2015 was developed and delivered with in-kind support from the Lebanon Mine Action Centre (LMAC), DanChurchAid (DCA) and the United Nations Mine Action Support Team (UNMAST) as a part of the United Nations Interim Force in Lebanon (UNIFIL).

The durable partnership between the OSCE OiT and the host country enables a seamless implementation of the project at the ground level. The Tajik Ministry of Defence, in its capacity as the training program host, provides training venues, in-country logistic support and junior instructors, while TNMAC provides training certification and validation. Trainings are organized at the Tajik Ministry of Defence's Engineering-Demining Regiment and at the Field Training Centre of the Military Institute.

In Kazakhstan, the tripartite MoU signed between the OSCE offices in Astana and Dushanbe as well as the Kazakh Ministry of Defence in August 2015, confirmed cooperation efforts from mid-2015 to mid-2018. The ICExH project's wide partnership network is a testament of its regional prominence and of its partner nations' interest to participate in this joint endeavor. It took OSCE OiT more than seven years to develop such a network. Sustaining the ICExH project partnership network will maintain regional cooperation momentum in addressing the issues relating to explosive hazards in Central Asia.

Wider Impact of the ICExH Project

The ICExH project enhances and supports continuous technical explosive hazard coordination and dialogue, which encourages broader confidence and security building (CSB) in Central Asia. Currently, the project is the only consistent and ongoing CSB measure addressing the issue of explosive hazards within the region.

In addition to supporting the progress of Central Asian States toward compliance with international disarmament

A USARCENT instructor explains the necessity of collecting an IED's forensic evidence on a mock-up device in Dushanbe, Tajikistan (October 2015).
Photo courtesy of OSCE/Nozim Kalandarov.

conventions, the ICExH project is helping to reduce threats to national security (i.e., IEDs laid by insurgents and terrorists, unplanned explosions at ammunition storage sites, and transnational crime). It also supports Central Asian States' aspirations to participate in U.N. peacekeeping operations with their explosive hazards reduction and response capacities. Graduates of the trainings, seminars and exchange programs are technical specialists and managers who are influential in terms of shaping policy and implementation measures to reduce the threat posed by explosive hazards in the region.

The project also supports the establishment of the Regional Explosive Hazards Training Centre in Tajikistan and regional explosive ordnance demilitarization trainings in Kazakhstan. Training opportunities will be provided to military, security and law-enforcement forces as well as other relevant civilian agencies. The ICExH project supports the wider role of the OSCE in mobilizing actors and developing a cooperation platform among its participant States in Central Asia. Through its multilateral capacity building and technical level dialogue approach, the OSCE OiT validates the case for confidence and security building in Central Asia.

See endnotes page 65

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Luka Buhin joined the OSCE Office in Tajikistan in February 2012 and served as a mine action officer before becoming the program officer in charge of the ICExH project in November 2014. Previously, Buhin was a part of the ITF Enhancing Human Security team and managed various national and regional mine action projects in Southeast Europe, South Caucasus and Central Asia between March 2006 and January 2012. Buhin holds a bachelor's degree in political science with a defense studies specialization and a Master of Science degree in international economics from the University of Ljubljana (Slovenia).

HDC personnel receive instruction from Supervisor Izzatov Yakub before entering the minefield.
Photo courtesy of Akbarov Firuz.

Building Tajikistan's National Capacity

by Bahriniso Shamsieva [Organization for Security and Co-operation in Europe]

Headquartered in Vienna, Austria, the Organization for Security and Co-operation in Europe (OSCE) is an international organization of 57 member States. Currently conducting 16 field missions, OSCE develops confidence building measures in the field of security while providing conflict-prevention capabilities and a capacity-building process for participating nations. These mine action activities are supported by the OSCE Permanent Council and implemented by field missions via partnerships with the host countries.

Contamination in Tajikistan

The Republic of Tajikistan is contaminated by landmines and unexploded ordnance (UXO) as a result of civil war from 1992 to 1997, insurgent incursions and mines laid along its borders. Tajikistan became a State Party to the Anti-Personnel Mine Ban Convention (APMBC) on 1 April 2000. Tajikistan made an explicit request to the OSCE Office in Tajikistan (OiT) to support the Tajikistan National Mine Action Programme in order to meet its obligations under Article 5 of the APMBC.

Supporting Demining Efforts in Tajikistan

In 2003, OSCE OiT began the first mine action program among all OSCE field missions. The mine action unit has a unique combination of capacities in the areas of program management, resource mobilization and management, and facilitation of cross-border cooperation efforts. The OSCE OiT mine action unit is developing and implementing projects on the national and regional levels.

In 2009, OSCE OiT shifted its approach from donor-funded management to self-implemented mine action projects that develop national capacities. Since then, it has contributed to the clearance of over 1.7 million sq m of mine/UXO-affected land and the destruction of over 9,580 mines and UXO through manual and mechanical clearance.

Element of Success: Partnerships

In the frame of the national program, OSCE OiT closely cooperates with the Republic of Tajikistan's Ministry of Defence (MoD) and the Tajikistan National Mine Action Centre (TNMAC). With support from OSCE OiT, Tajikistan's

Quality Assurance Officer Kalandarov Saidnuriddin, and the head of HDC, Firuz Asadbekod, brief Afghan colleagues on humanitarian demining operations during a field visit to the minefield in the Vanj district, Tajikistan.
Photo courtesy of Akbarov Firuz.

MoD has become one of the key actors addressing mine/UXO threats in Tajikistan. The role of Tajkistan's MoD within the Tajikistan Mine Action Programme is significant and ranges from temporarily seconding military personnel to assisting international demining operators in establishing the MoD's own humanitarian demining capacities. In 2012, the Office for Military Cooperation and the U.S. Embassy in Dushanbe donated a Mini MineWolf to the MoD to help the humanitarian demining program remove mines located on the Tajik-Afghan border. Tajikistan's MoD plans to use the Mini MineWolf in mine-contaminated areas within the country as well as abroad in peacekeeping operations.

TNMAC is the OSCE OiT counterpart in Tajikistan that facilitates implementation of humanitarian demining operations in close partnership with the MoD. In January 2014, TNMAC was established as a governmental institution with the responsibility to coordinate and regulate mine action-related activities in the country. It provides administrative services and day-to-day oversight of the MoD demining teams in the field on behalf of the Tajikistan office.

Since 2013, the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) has been the main donor to the OSCE Mine Action Unit. Funding enables projects that support the government of Tajikistan in meeting its obligations under the APMBC and assists Tajikistan in developing its humanitarian demining capacity. The project complements the national mine action strategy and annual working plans. The project aims to enhance the national humanitarian demining capacity of the OSCE counterpart, TNMAC, and increase the resources that can be deployed for mine clearance operations in the country.

Strategic Planning

With the support of OSCE OiT, the MoD's 2013–2016 strategic plan on humanitarian demining was developed to sustain Tajikistan's capacities and efforts to fulfil its responsibilities to the APMBC and train subdivisions to participate in on-going peacekeeping operations. The Humanitarian Demining Company (HDC), working within the organizational structure of the MoD, will enhance its own capacity and will operate closely with TNMAC and all mine action stakeholders in Tajikistan.

Additionally, the strategic plan is redefining the role of the MoD by mainstreaming its humanitarian demining capacities in support of building peace and stability through peacekeeping operations beyond 2017. The proposed exit strategy envisons the MoD deploying its humanitarian demining specialists and/or units of the HDC to peacekeeping operations and field missions abroad. Moreover, military and civilian personnel

A Mini MineWolf machine in the Panj district along the Tajik-Afghan border.
Photo courtesy of OSCE/Azamjon Salohov.

who are engaged in mine action and are planning on taking part in U.N. peacekeeping operations in the region will benefit.

Conclusion

Through its mine action unit, OSCE OiT continues to improve public security and build confidence at the national and regional levels. By coordinating tasks among mine action stakeholders in Tajikistan, OSCE OiT supports the government as it fulfills its obligations under Article 5 of the APMBC by April 2020. It is also building a platform for Tajikistan to cooperate with the relevant government institutions and authorities, regional counterparts, as well as the international mine action community and its donors.

After meeting the APMBC deadline, the government of Tajikistan will have a professional humanitarian demining capacity that works in accordance with all international standards and can be deployed to address any residual risk of explosive contamination that may arise. Tajikistan has also demonstrated that its HDC is prepared and equipped to participate in U.N. peacekeeping operations as humanitarian mine action specialists. This would reinforce Tajikistan's full membership in the international community, fostering self-respect and dignity alongside the understanding and adoption of wide-ranging humanitarian principles.

The OSCE mine action unit facilitates the legislative framework for humanitarian mine action in Tajikistan for its capacity development with a long-term, self-sustainable system. OSCE OiT will continue to support Tajikistan in addressing its mine/UXO problem and will continue to emphasize national capacity building.

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Afghanistan's National Mine Action Strategic Plan (2016-2021)

by Mohammad Akbar Oriakhil [United Nations Mine Action Centre for Afghanistan]

Afghanistan suffers from severe landmine and explosive remnants of war (ERW) contamination, mostly as a result of the Soviet-Afghan War (1979–1989), internal conflict lasting from 1992 to 1996, and the United States-led coalition intervention in late 2001.[1]

There are around 617 sq km of areas remaining to be cleared as of end March 2016, new contamination is arising as a result of the ongoing nationwide non-technical survey which covers both the contaminated areas left from the fighting (1979-2001) and the contamination resulted from the ongoing war since 2001 between the international forces allied with the Afghan government against the non-State armed groups. Additionally, firing ranges used by international forces throughout the past 14 years have also produced ERW contamination. Based on the Anti-Personnel Mine Ban Convention (APMBC) extension request work plan, all confirmed hazardous areas (CHA) and suspected hazardous areas (SHA) within the territory should be cleared by March 2023.[2]

The vast mine/ERW contamination poses an immediate risk to personal safety in Afghanistan. In 2014 alone, there were 1,296 recorded mine/ERW casualties (575 killed/721 injured), of which more than 98% are civilian" were civilians.[3] In total, there have been 24,300 recorded casualties (4,802 killed/19,498 injured) between 1979 and 2014.[4] Access to the scarce victim assistance services in Afghanistan is severely hindered by poor infrastructure, continued conflict and poverty.[5]

The Mine Action Programme of Afghanistan (MAPA) has surveyed and cleared almost 80 percent of all known mine/ERW contamination throughout the country. MAPA's main functions are coordinating, planning and setting priorities, information management, mobilizing resources, and ensuring quality of mine action services, advocacy and communication. The Directorate of Mine Action Coordination (DMAC), which works under the Afghanistan National Disaster Management Authority, partners and coordinates with the United Nations Mine Action Centre for Afghanistan (UNMACA) under the United Nations Mine Action Service (UNMAS).

The National Mine Action Strategic Plan (NMASP) workshop, 18 October 2015.
All photos courtesy of UNMACA.

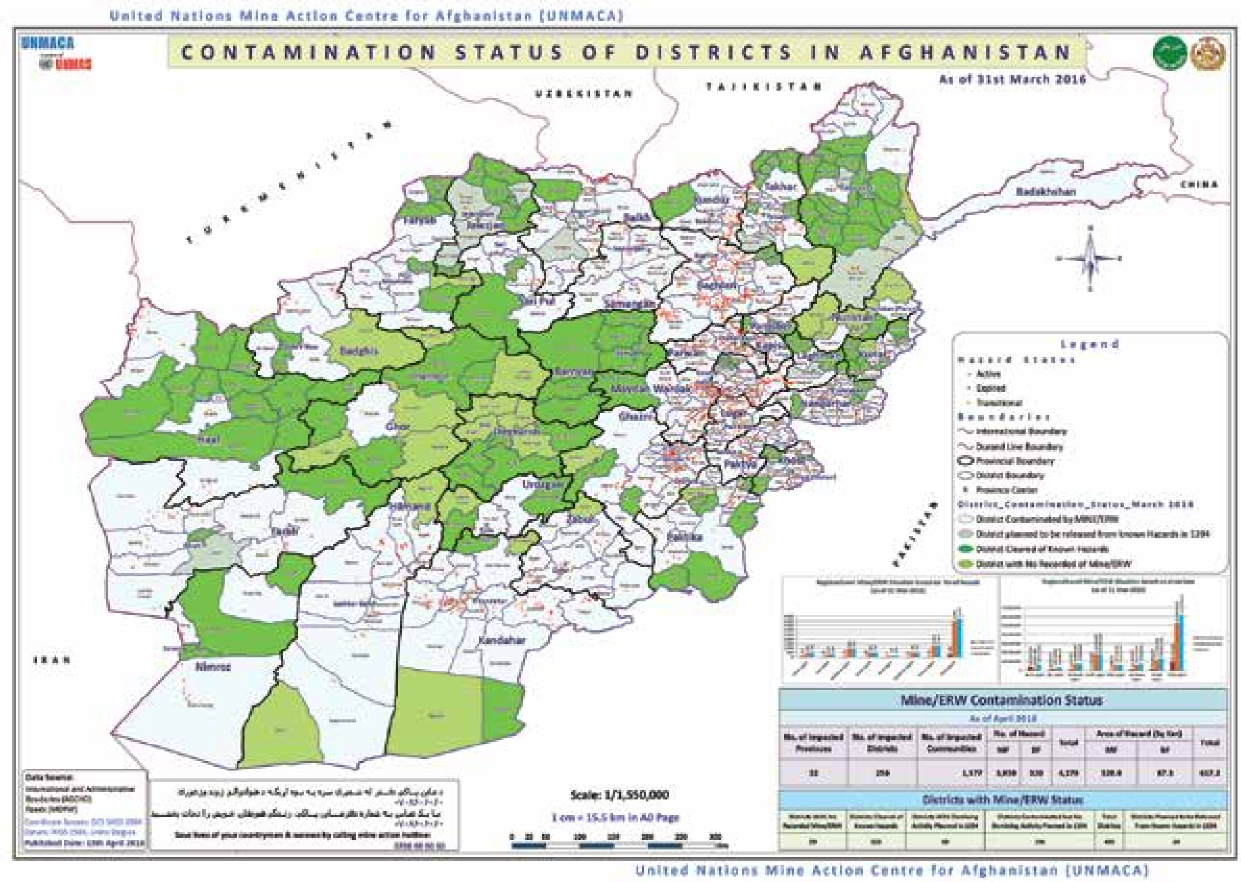

Figure 1. Contamination status of districts in Afghanistan as of 31 March 2016.
Figure courtesy of UNMACA.

There are approximately 50 mine action nongovernmental organizations (NGO) and commercial demining companies implementing mine action projects in Afghanistan.

Based on the March 2016 UNMACA report, there are still 617 sq km (235.9 sq mi) of residual contamination left to be cleared excluding the firing-range contamination.[6] Figure 1 shows the scope of the current contamination levels in the country.

Need for a Strategic Plan

UNMACA developed the first MAPA strategic plan for 2008–2013, as well as a document titled "Mine Action in Afghanistan: The Way Ahead," which was released in May 2006, outlining mine action end goals for Afghanistan and a plan for transitioning the mine action program to the Afghan government.[2,3,7] These strategic plans were developed by only a few experts and were not properly communicated to various stakeholders, thus reducing the plans' effectiveness. Since 2013, the APMBC extension work plan is the only available strategic plan. This document mainly focuses on the survey and clearance of mines and ERW, while other aspects of mine action (i.e., facilitating development, gender mainstreaming, mine/ERW risk education, advocacy and victim assistance) are not covered. Hence, stakeholders needed a comprehensive strategic plan covering all aspects of mine action that could steer the program and coordinate activities among its stakeholders to achieve the program's end goals.

NMASP Development Process

Two workshops were conducted in October 2015 and between January and February 2016 in Kabul, where participants representing DMAC, UNMACA, implementing partners, relevant government ministries and some donors attended. Participants in the workshop reviewed the program's vision and mission statements, conducted SWOT and PESTLE analyses, and determined strategic risks and mitigating factors of the program.[8,9] At the early stages of deliberation, five strategic goals were determined:

1. Transition to national ownership
2. Facilitate development
3. Engage with other sectors
4. Implement the five pillars of mine action
5. Gender and diversity mainstreaming.

However, after further discussion among the management of DMAC, UNMACA, UNMAS and the implementing partners, the first goal was deemed to already be in progress. Additionally, the stakeholders decided the fourth step on the implementation of the five pillars of mine action would be divided into two parts to address both preventive functions (clearance, mine/ERW risk education, stockpile destruction and advocacy) and responsive functions (victim assistance and advocacy). The initial strategic goals were as follows:

1. Facilitate development
2. Engage with other sectors
3. Implement the five pillars of mine action
   - 3.1 Preventative functions to reduce impact of mines and ERW
   - 3.2. Responsive functions to mitigate the consequences of mine/ERW accidents
4. Gender and diversity mainstreaming.

In addition, five working groups were assigned and each group conducted a number of sessions to determine 33 objectives and 108 action plans as well as indicators, milestones, potential risks and how to mitigate risks. During the second workshop, the working group outputs were reviewed and the statements for each goal were updated. The template and format of the National Mine Action Strategic Plan (NMASP) were discussed and participants determined that a follow-up session for governmental approval was necessary.

Strategic Goals and Objectives

Goal 1: Facilitating development. *To establish and maintain confidence that all aspects of MAPA's planning, prioritization, operations, monitoring and evaluation are informed by and assessed against the development requirements of the people and government of Afghanistan.*

Objectives include:

- Identify development projects for the next five years, assess mine/ERW contamination of these project sites, mobilize resources and plan clearance operations from 2016 to 2020
- Incorporate mine/ERW challenges into national priority programs and sustainable development goals as well as other government development frameworks
- Implement the mine action program as part of development policies for projects and provincial strategic plans in key government ministries.

Goal 2: Engaging with other sectors. *To ensure that ministries, departments and agencies of the government of Afghanistan, as well as national and international NGOs, and private sector stakeholders take into account the significance of MAPA's strategies, priorities and activities.*

Objectives include:

- Incorporating mine action into the following sectors: education, health, economic, private, agriculture, rural rehabilitation, social protection, security, infrastructure, and natural resources
- Drafting bilateral agreements with regional and international organizations on joint programming.

Goal 3.1: Preventive functions to reduce the impact of mines and ERW. *To determine and implement appropriate and effective actions to reduce current and future impacts of mine and ERW contamination on Afghan people and government through clearance, stockpile destruction, mine/ERW risk education and advocacy.*

Objectives include:

- Enhance fundraising efforts to keep mine action activities on track
- Quantify hazards resulting from post-2001 contamination
- Complete survey of remaining non-surveyed areas
- Keep the extension request plan on track
- Improve the capacity of the program to respond to new types of contamination
- Mainstream mine/ERW risk education into government line ministries, community networks and civil society organizations
- Support the government on destruction of unrecorded, sporadic, stockpiled and unserviceable ammunition
- Reduce civilian casualties, especially the protection of children from mines and ERW
- Adopt and update policies and Afghan mine action standards/procedures in accordance with International Mine Action Standards (IMAS).

Goal 3.2: Responsive actions to mitigate the consequences of mine and ERW accidents. *To determine and implement appropriate and effective actions to reduce the impacts arising from mine/ERW accidents on the people and government of Afghanistan.*

Objectives include to advocate for and support

- The government of Afghanistan in developing national disability and victim assistance policies
- Relevant line ministries (Ministry of Labor, Social Affairs, Martyrs and Disabled [MoLSAMD], Ministry of Women's Affairs [MoWA], and the Ministry of Foreign Affairs [MoFA], etc.) in developing disability and victim assistance inclusive policies and strategies
- MoLSAMD and other line ministries/institutions in conducting national disability and victim assistance surveys and development of a disability database
- The allocation of funds for direct services provision for disability and victim assistance activities.

Goal 4: Mainstreaming gender and diversity. *To ensure*

The end of the first workshop, 22 October 2015.

that all gender and diversity groups participate in and benefit from the work of MAPA and that MAPA benefits from the insight and participation of gender and diverse groups in all aspects of its work.

Objectives include:

- Develop a MAPA gender and diversity policy
- Increase employment of women, people with disabilities and other marginalized groups
- Manage, design, implement and evaluate gender and diversity-sensitive projects
- Raise awareness within MAPA and its stakeholders of gender issues
- Improve consideration of gender and diversity issues in coordination mechanisms (building State capacity, problem-driven integrative adaptation, etc.)
- Establish a gender department and allocate a budget for gender-based activities
- Continue to build capacity of gender departments and promote their role in mainstreaming gender and diversity policy.

The Way Ahead

This NMASP document was launched in early April 2016 and a review committee was established to monitor and regularly review the process of implementing the objectives while providing progress reports to UNMACA and DMAC.

Conclusion

Compared to the previous strategic plans, the preparation of these goals and objectives is more inclusive of a wider range of stakeholders. Participants agreed to all goals and objectives in the NMASP. Additionally, the plan incorporates the pillars of mine action and is concurrent with the Maputo Action Plan 2014.

See endnotes page 65

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Mohammad Akbar Oriakhil was born in Kabul, Afghanistan and graduated from Habibia High School before immigrating to Pakistan where he studied under the International Rescue Committee Construction Engineering Program. In August 1995, he joined Afghan Technical Consultants and worked as assistant operations officer, assistant site officer, supervisor and operations officer until February 2003. He then joined UNMACA as operations assistant and was promoted in 2006 to area manager. Oriakhill is now the planning and program manager with UNMACA. He is also a graduate of the Center for International Stabilization and Recovery's 2010 Senior Managers' Course in ERW and Mine Action.

Field Notes

The UXO Sector in Laos

by Titus Peachey [Mennonite Central Committee]

Nearly fifty years after the nine-year Secret War (1964–1973), Laos is the scene of a US$35–$40 million annual enterprise, employing more than 3,000 workers who, with assistance from governments and non-governmental organizations (NGO) around the world, are engaged in unexploded ordnance (UXO) clearance, victim assistance and mine risk education (MRE).[1] The 2.2 million tons of bombs included an estimated 270 million cluster munitions, many of which failed to detonate on impact and created a lethal landscape to which villagers returned after the war. The inevitable post-war casualties now number more than 20,000.[2] A high percentage of victims over the past several decades were not alive when the bombs fell.[2]

In light of these statistics, many have declared that the task of clearing ordnance in Laos will take a century or more. In the early 1980s, there were no surveys or clearance operations, only bombs and a steady stream of sad stories. Today, the debate has shifted to the state of progress and the eventual end game. What indicators should be used: the number of hectares cleared? The amount of ordnance destroyed? The number of casualties? Or should the focus be on the number of UXO incident survivors still needing rehabilitative care? What about the number of economic development and poverty reduction initiatives that can move forward? And finally, when can the task be declared complete?

Recent developments within the UXO sector offer some help in answering these questions. While no one believes that every last piece of UXO in Laos will be destroyed, there is a growing sense of optimism that the next 10–20 years of quality work will significantly improve the safety of Lao villagers. Through coordinated planning, hard work and persistence, important pieces are finally falling into place.

Administration

The National Regulatory Authority (NRA), active since 2006, is responsible for the oversight of the UXO sector in Laos, including policy, coordination, standards and quality management. It is chaired by the deputy prime minister and includes representatives from 17 different government ministries, and the United Nations Development Program and U.S. State Department provide technical advisors.[3] A UXO Sector Working Group chaired by the NRA meets regularly to review progress and establish annual goals. In 2010, UXO clearance was established as the ninth Millennium Development Goal. While not all of the plans on paper have been integrated into action on the ground, this coordination at the national level is having a positive effect overall.

A villager hoes her garden in Phonsavan, Laos, a dangerous activity in a land littered with unexploded ordnance (1984).
Photo courtesy of Mennonite Central Committee/Linda Gehman Peachey.

Year	Submunitions via Battle Area Clearance	Submunitions via Roving Team	Other UXO via Battle Area Clearance	Other UXO via Roving Team	Total
2014	27,048	31,450	17,699	16,743	92,940
2013	24,320	15,967	22,127	19,073	81,487
2012	29,662	14,164	22,978	13,162	79,966
2011	19,431	13,359	16,981	13,051	62,822
2010	21,031	14,417	15,772	18,376	69,596

Figure 1. Number of submunitions and other UXO destroyed in Laos, 2010-2014. Information sourced from the *Landmine and Cluster Munition Monitor*, 2011-2015.
Figure courtesy of the author.

Clearance

UXO clearance in Laos is managed by UXO Lao, the national enterprise, along with international humanitarian clearance operators including APOPO, The HALO Trust, Handicap International (HI), MAG (Mines Advisory Group), Norwegian People's Aid (NPA) and numerous commercial operators. Clearance teams in Laos routinely destroy between 60,000 and 100,000 pieces of ordnance a year, with numbers rising in recent years.[4]

Over the past several years, a debate within the UXO sector was sparked by clearance operations on land that had very little ordnance, leading to impressive reports on the number of hectares cleared albeit with little impact on reducing the actual threat to Lao villagers. To overcome this problem, all clearance operators have now adopted the evidence-based survey method to identify areas where clearance is needed.[5] This method relies initially on evidence such as strike data, incident reports and roving team data to help determine areas that are highly contaminated. Identified areas are then methodically checked for UXO via a technical survey to determine if full-scale clearance operations should proceed.

The evidence-based survey method is already providing planners with more detailed information and allows clearance teams to concentrate their efforts on highly contaminated land. The results during the first 10 months of 2015 are highly encouraging, showing more than double the amount of UXO destroyed per hectare when clearance efforts follow the evidence-based survey.[6] Planners are using the survey results to create a database of confirmed hazardous areas (CHA) that can be prioritized for clearance. In 2016, an additional grant from the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) is allowing the survey to move forward without pulling resources away from ongoing clearance operations. According to the NRA, the evidence-based survey should be completed in three of the nine most contaminated provinces in 2016, with the remaining six most contaminated provinces targeted for completion by 2020.[7]

In a recent presentation to a UXO Sector Working Group Meeting, NRA Director General Mr. Phoukhieo Chanthasomboune noted that there are already 3,000 CHAs awaiting clearance, amounting to three-to-four years of work.[8] This is in stark contrast to the early days of clearance. When MAG deminers first began working in Xieng Khouang Province in 1994, they were confronted with vast areas of UXO-contaminated land that defied definition. As clearance operations began, the deminers created small islands of cleared land in the midst of fields, villages and hillsides that were still littered with varying levels of UXO.[9] For years, clearance teams kept detailed records of areas cleared and the amount of UXO destroyed, yet they were without a clear picture of the size of the total task. To now be able to clearly define specific areas of highly contaminated land throughout the country and prioritize them for clearance is a big step toward creating a realistic assessment of the scale of the problem along with a timeline and budget for completing the task.

Still to be factored into the survey and clearance tasks ahead are the provinces with lower levels of contamination such as Phongsaly, Oudomsai and Bolikhamxai, where lethal ordnance still threatens villagers and hampers economic development. Just one piece of UXO in a garden are enough to create a risk, and a child killed while digging up bamboo shoots is a loss that can traumatize an entire village. The growing optimism present among planners who see real progress in the big picture is likely not felt in these areas where help is yet to arrive.

A European Union report highlights the dynamic of population movements as another complicating factor in making land safe for Lao villagers.[10] Population growth along with economic development initiatives such as mining, hydropower and forestry sometimes result in people moving into areas that include highly contaminated land. These factors make it imperative that economic development and poverty reduction initiatives be coordinated with UXO clearance at all levels so that villagers can earn their livelihood in safety.

Year	# of Casualties
2015 (First 10 months)	38
2014	45
2013	42
2012	56
2011	99
2010	117
2009	134
2008	310

Figure 2. UXO casualties in Laos, 2008–2015. Information sourced from the *Landmine and Cluster Munition Monitor*, 2011–2015.
Figure courtesy of the author.

Victim Assistance

One of the more important progress indicators for the UXO sector is the number of UXO casualties. Thankfully, as shown in Figure 2, the number of new victims has decreased significantly over the past years.[4]

This decline in casualties can be attributed to several factors. Clearance removes lethal ordnance from the land and reduces the number of potential encounters that villagers may have with UXO. In addition, MRE helps children recognize UXO and understand the dangers it poses. Risk education was formally included in the national school curriculum in 2014, although the production of resources is still limited.[6] Villagers also know that when they find ordnance on the surface, they can call a roving team to safely destroy it.

While the number of new casualties has clearly dropped, the estimated number of survivors of UXO incidents that still live in the country was 15,000 in 2012.[4] Many of these survivors will need medical, rehabilitative and/or psychosocial services over the course of their entire lifetime.

Through funding from PM/WRA, World Education, Inc. provides comprehensive case management for UXO incident survivors in Xieng Khouang Province via a Victim Assistance Support Team (VAST). In addition, all UXO survivors in Laos are eligible to have transportation and medical costs reimbursed through their war victim's medical fund. Once informed, VAST members visit UXO incident survivors and their family members in the hospital. The fund covers per diems for family members to stay with survivors while in the hospital and covers the cost of initial and ongoing care and treatment. Support is also available for much needed home renovations to better accommodate the survivor.

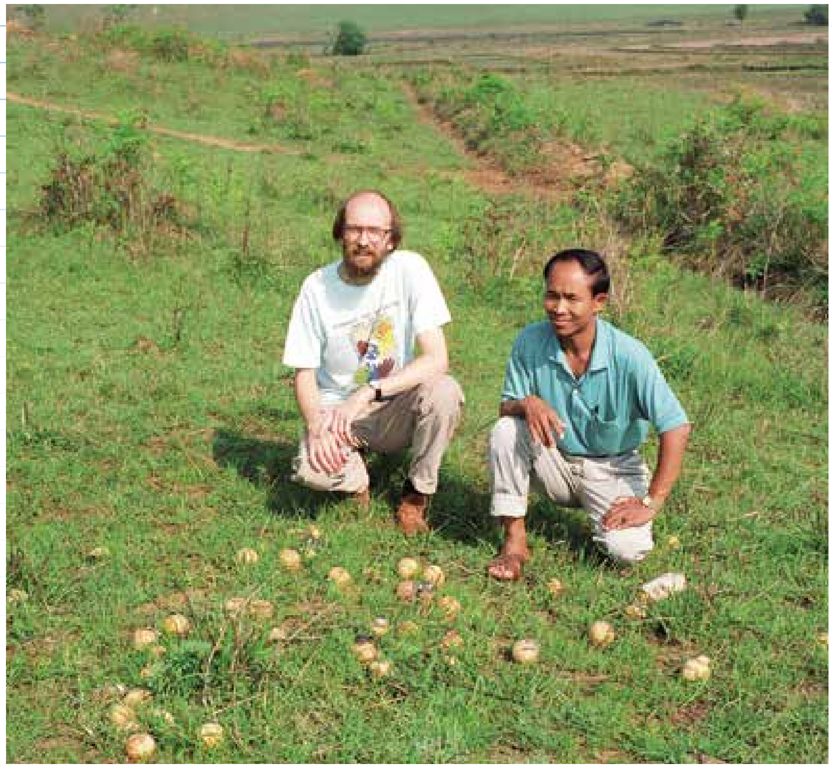
There are challenges, however. Villagers cannot access the fund if the medical system does not communicate the need, and survivors in rural areas face very difficult transportation obstacles. In these situations, survivors do not always receive the care they need.

The same reality is true for survivors needing artificial limbs and other rehabilitative services. The Cooperative Orthotic and Prosthetic Enterprise (COPE) works with the Lao Ministry of Health Center for Medical Rehabilitation to increase access to quality prosthetic and orthotic services in Laos. COPE receives funding from the Leahy War Victims Fund administered by the United States Agency for International Development (USAID), as well as funding from the governments of Australia, Canada and Norway, and from private donors, both institutional and individual. Five rehabilitation centers are located in Luang Prabang, Xieng Khouang, Savannakhet, Champassack and Vientiane Provinces. Accommodation at these centers is provided by the Lao government while COPE reimburses survivors for transportation costs and a family caregiver; however, Laos' rugged terrain and poor transportation infrastructure are formidable barriers to overcome.

In response, COPE established an outreach program (COPE Connect) in 14 provinces, forming a network of 700 health officials at provincial and district levels to assist with clinical field trips to assess the need for prosthetic and orthotic devices. In addition, via funding from the U.S. and Canadian governments, COPE hopes to begin a three-year program of mobile clinics in 2017. Of the approximately 500 patients who received prostheses via COPE's services, more than a third were UXO survivors.[11]

Through support from France, the Netherlands, Norway and the European Union, HI administers a comprehensive UXO threat reduction project that includes survey, clearance, risk education and victim assistance. In Savannakhet Province, HI's victim assistance work supports people with disabilities from all causes, including UXO accidents. Support includes livelihood training and coaching, disability rights and equality training, along with help in overcoming barriers to necessary medical and rehabilitation services. HI's work with victims is beginning to focus more on entire communities made vulnerable by UXO as well as on the economic and social integration of these communities into the broader society. HI supports the development of a national disability policy that is inclusive of UXO survivors' needs by working with the National Committee for Disabled People and Elderly and the National Regulatory Authority.

Another area of significant need is the issue of psychological trauma, but Laos is not yet sufficiently equipped with trained personnel for this area. A level of psychosocial and



The author and Bua la, National Bomb Removal Project Director, survey unexploded cluster munitions in a pasture near Phonsavan, Laos (1994).
Photo courtesy of Mennonite Central Committee/Titus Peachey.

peer support is provided by the World Education, Inc. in Xieng Khouang Province. The Quality of Life Association, a Lao NGO, helps by providing skills training for survivors who need to adjust their means of livelihood. In addition, social stigma is often associated with disabilities, which is an issue that HI addresses through its victim assistance work in Savannakhet Province. This requires broader work within family systems and the general public to create a supportive and encouraging environment so that everyone can thrive, regardless of physical limitation.

The NRA initiated a Survivor Tracking System designed to provide an ongoing survey of all survivors' needs. By the end of 2014, data from 10 provinces was entered into the database. Furthermore, the NRA adopted a new Victim Assistance Strategic Plan in 2014, addressing the comprehensive needs of survivors, but implementation of the plan is lagging, particularly at the local levels due to a number of reasons including a lack of trained personnel and proper equipment, difficult transportation and poor communications infrastructure.

Funding and Political Relations

In the early years of the UXO sector in Laos, the effort was determined and innovative yet bore no connection to the scale of the problem. Initiated in 1994 with private funding from the Mennonite Central Committee, the work quickly gained the attention of governments and other larger donors. However, funding was cautious and capacity was small. By 2000, funding from governments totaled only US$6.6 million. The United States was the highest funder that year, contributing almost $1.5 million dollars.[12]

Funding for clearance in Laos began to rise sharply in 2010, and in 2014, there were contributions from 13 different nations plus the European Union. Japan, a non-belligerent in the war has been a major funder. Since 2010, the U.S. contributions have more than tripled and now make up nearly half of the total.[4]

PM/WRA supported the work of the following implementing partners in FY 2014: Catholic Relief Services, The HALO Trust, Health Leadership International, MAG, NPA, Spirit of Soccer, Sterling Global and World Education, Inc.[13] USAID's Leahy War Victims Fund provided funding to the Cooperative Orthotic Prosthetic Enterprise.

Funding increases from the United States are attributed to several factors:

- Concentrated education and advocacy initiated by Legacies of War, especially among members of the Lao diaspora in the United States. A speaker's tour planned by Legacies of War and funded by PM/WRA brought a Lao UXO survivor and a deminer to 12 U.S. cities in 2013. Repeated contacts with congressional champions, letters from former U.S. ambassadors to Laos and the dedication of congressional and State Department staff resulted in a growing commitment to complete the task in Laos.
- Warming political relations between Laos and the United States were also important. Then Secretary of State Hillary Clinton visited Laos in 2012 and met a UXO survivor while touring the COPE Center in Vientiane. Deputy National Security Director for Strategic Communications Ben Rhodes visited Laos in 2015, as did Secretary of State John Kerry in January 2016. Laos' chairmanship of ASEAN (Association of Southeast Asian Nations) brought the Lao Prime Minister to the United States for an ASEAN Summit

A cluster bomblet lodged in the dike of a rice paddy in Nanou village, Laos (2005).
Photo courtesy of Mennonite Central Committee/Titus Peachey.

Meeting in February 2016, and President Obama will visit Laos during the ASEAN meetings in September 2016.

- Appropriations language in the U.S. Congress gives priority to clearance operations in areas where the ordnance is of U.S. origin. In a visit to Laos in October 2015, Deputy National Security Advisor Ben Rhodes remarked, "The U.S. created this problem. We have a moral responsibility to help clean it up."[14]

Conclusion

For Laos, the next two decades are critical. Will this new survey methodology and clearance operations extend to all the affected provinces? As the true scale of the problem becomes clear, will funding remain strong? Will comprehensive care for UXO victims and their communities be integrated into a national strategy for all who struggle with disabilities? On the cusp of so much promise, it is essential that the commitment on the part of donors does not waver and that the United States continues to be the leading donor. The capacity and technical expertise are in place. The opportunity to resolve this legacy of war has never been clearer.

See endnotes page 65

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Titus Peachey was co-director of the Mennonite Central Committee (MCC) program in Laos (1980–1985), and returned to help set up the humanitarian demining program (1994), along with (MAG) Mines Advisory Group and the Lao government. Peachey retired from MCC in 2016 as the director of peace education. Peachey currently serves as Chair of the Legacies of War Advisory Board.

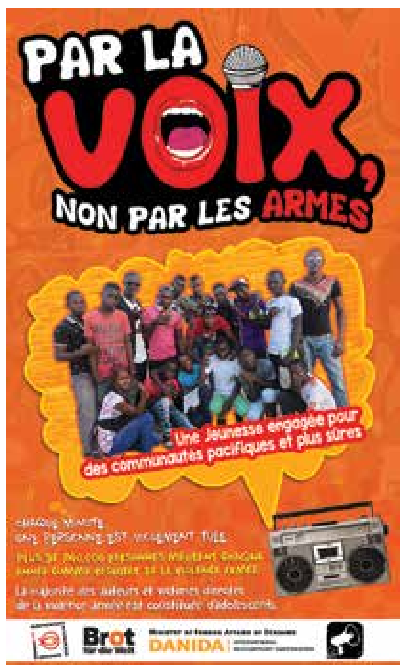
Field Notes

Armed Violence Reduction in Central Mali: A Community-based Approach

by Sonia Pezier [UNMAS] and Jean-Denis Larsen [DanChurchAid]

According to the Small Arms Survey, around 526,000 persons are killed every year as a result of armed violence, and many more sustain injuries requiring medical and rehabilitative care that severely impacts their lives.[1] In West Africa, the propagation of small arms and light weapons (SA/LW) escalates armed conflicts and affects the security and the stability of the entire Sahel region.

In Mali, the proliferation of SA/LW leads to numerous incidents, mainly caused by intra- and inter-community violence and poor gun-storage practices at the household level.[2] In order to reduce these risks, the United Nations Mine Action Service (UNMAS) launched a pilot project, which was implemented by DanChurchAid (DCA) from March 2014 to July 2015. The project aimed to improve the security situation and reduce tensions within and between communities in the region of Mopti (central Mali), which is affected by armed violence. It used a community-based approach to ensure ownership of the project by the community.



A concert banner.
Photo courtesy of UNMAS.

SA/LW Survey

A survey was first conducted in the Mopti region with the following objectives:

- Report on the number of SA/LW stored in homes within the Mopti and Douentza districts
- Conduct a needs assessment and inform the subsequent strategy for armed violence reduction (AVR) and SA/LW awareness through a thorough analysis of the scope and nature of the problems and their underlying causes. Establish a baseline for evidence-based impact monitoring of the activities in order to develop community-owned safety strategies and improve risk awareness.

The survey found that 17 percent of people consulted admitted to owning firearms. "Self-protection" figured highly in both self-reported and perceived reasons for firearms possession. The survey shows that an estimated 10 percent of the population was victim to armed violence in 2013. Participants identified road robberies, house burglaries and conflict between farmers and pastoralists as the three most significant concerns related to armed violence.

Attitudes toward disarmament were generally positive, although 50 percent of the respondents said that disarmament did not concern them or did not apply. While young males were most often identified as perpetrators of armed violence, women and youth were less in favor of disarmament than their elders (both men and women).

Community Safety Planning

After analyzing the results of this survey, the community safety planning (CSP) methodology was used to define activities and implement safer community action plans. By first selecting a community safety committee, the CSP method empowers communities to develop plans that they can implement themselves.[3] This capacity-building approach to AVR programming consists of concrete activities aimed at empowering and improving the resilience of local populations in order to anticipate, analyze, prevent and manage threats to their security, as well as to respond to incidences of armed violence and conflict. The CSP method is participatory and places communities in control of all phases of the project cycle, from the initial assessments to the final evaluations. The results of the needs assessment identified a higher prevalence of armed violence in some areas than others, thus the project focused on the municipalities of Konna

An awareness leaflet.
Photo courtesy of UNMAS.

and Boroundougou (Mopti district), and Gandamia and Deberé (Douentza district).

Operational Achievements

The delivery of SA/LW risk education sessions was one of the project's cornerstones. The sessions promoted safe behaviors for at-risk groups and firearm owners. The project reached a total of 13,930 people (35 percent women and girls) in 20 villages and distributed 11,446 awareness leaflets. Both before and after the sessions, a sample of the beneficiaries received questionnaires to measure whether their knowledge and awareness toward SA/LW issues had increased.

Moussa Fofana, the village chief of Takoutal, remarked that the AVR project "has brought about many changes in the villages, one among all is the fact that children are no longer tempted to play with SA/LW and their ammunition: when they see something suspicious they go and inform their parents."

In parallel, DCA distributed 120 wooden gun boxes to beneficiaries who legally possess a firearm, thus encouraging people to better secure their weapons, and thereby reducing accidents and loss of life. Each box contained a copy of Law N. 04-050 concerning firearms and ammunition ownership in Mali and an instruction leaflet on how to use the gun box.

Under the heading of *Jeunesse et musique face aux armes légères* (Youth and Music Against Small Arms), DCA aimed to empower youth to advocate for dialogue while raising awareness of the dangers and risks associated with SA/LW in an effort to discourage youth from arming themselves. A concert organized in December 2014 gathered more than 1,000 people; the national TV channel ORTM and local radio stations in Mopti and Douentza districts covered the event.

Another important component of the project was the creation or re-establishment of peace and mediation committees as well as surveillance committees. Peace and mediation committees are generally composed of religious leaders, traditional leaders such as the *forgerons* and *griots*, village chiefs and other influential community members. These committees handle family disputes and intra- and inter-community arguments, and therefore play a key role in promoting peace and forgiveness among the parties. The surveillance committees provide protection to the village through an early warning system mechanism, which includes reporting anything suspicious to the village chiefs and ensuring that unattended animals are not damaging the crops. These activities address the needs identified by the communities for a sustainable mechanism to settle conflicts.

Impact of the Project

At the end of the project, the AVR teams conducted an impact assessment in 20 target villages, which shows a threefold impact.

Firstly, all participants recognized that the project significantly contributed to a reported decrease in security incidents and conflicts between communities. The target population noticed that relations and social cohesion between different social groups improved due to better dialogue and cooperation between the communities. The establishment of peace and mediation and surveillance committees helps the population to feel safer and has provided a means through which to share concerns. Conflicts are now managed at the village level, with security as the common goal. Moreover, the reduction of tensions and security incidents facilitated the movement of people and goods.

The 20 young artists before the concert.
Photo courtesy of DCA.

Awareness activities changed how people behave in regards to handling and storing SA/LW, and has helped to decrease the number of SA/LW accidents. The distribution of gun boxes helped increase safe weapons storage practices; the beneficiary communities are now aware of the Malian laws regulating SA/LW possession.

Moreover, the CSP methodology enabled a high level of local ownership of the project, which has empowered communities to take action and improve their own security through enhanced conflict management practices at the village level. The participatory approach and the involvement of women in the committees have also impacted gender perceptions. The Safer Community Committee members are now practicing their newfound skills in mediation, advocacy and SA/LW risk education.

Conclusion

Mali is facing several challenges linked to armed conflict, terrorist activities and intra-community violence. Armed violence reduction activities are a key enabler of stabilization and development efforts, especially in the central and northern regions of Mali. In line with the implementation priorities of the Agreement for Peace and Reconciliation in Mali signed in June 2015, such a project should be considered good practice for restoring social cohesion amongst communities as it complements peace education and effective security and justice mechanisms.

See endnotes page 66

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Field Notes

Explosive Remnants of War: A Deadly Threat to Refugees

by Dr. Ken Rutherford and Andrew Cooney [Center for International Stabilization and Recovery]

The deadly legacy of explosive remnants of war (ERW), including landmines, improvised explosive devices (IED) and unexploded ordnance (UXO) is increasingly a threat to refugee populations, economic migrants and internally displaced persons (IDP) in countries throughout Africa, Europe, the Middle East and Southeast Asia.[1]

By the end of 2014, the implications of persecution, conflict and other factors forcibly displaced approximately 59.5 million people worldwide. This number is comprised of 19.5 million refugees and roughly 38 million IDPs.[2] Refugees from the Middle East are at extreme risk since they primarily travel across the Balkans, including Bosnia and Herzegovina, Syria, and Turkey, which have mines planted along their borders and UXO from previous conflicts scattered throughout their territory. In this case, ironically, instead of being a threat to ambulatory refugee populations, mines can be the original cause for the displacement of civilians in their own countries.

The use of mines, IEDs and UXO in highly populated areas and along transportation routes occasionally forces people to flee due to fear of injury or death, positioning ERW as a major determinant of civilian displacement. This was demonstrated recently in Libya, when roughly 60,000 people fled from an uprising and were subsequently delayed in their return as a result of ERW contamination in residential areas.[3] These myriad effects of mines both as causes of migration and impediments to migration is displayed in Table 1.

Afghanistan, Iraq and Syria are three of the most landmine-contaminated countries in the world. Refugees, IDPs and migrants who cross through these states are at a tremendous risk for both injury and death. The armed forces under former Iraq President Saddam Hussein planted hundreds of thousands of mines near the Iran-Iraq border during the Iran–Iraq War (1980–1988), and many still threaten refugee populations.[4] According to the International Campaign to Ban Landmines (ICBL), anti-personnel (AP) mines were used in recent conflicts, such as by the Gaddafi regime in Libya and Syria.[5] The HALO Trust estimates that Afghanistan "is one of the most mined countries in the world with estimates of up to 640,000 landmines laid since 1979" and that "[m]ore than three decades of conflict have also left the country littered with unexploded ordnance (UXO)."[6]

In the Middle East, the Islamic State of Iraq and Syria (ISIS) has altered the humanitarian mine action landscape, increasing the threat of injury and death through the use of explosive devices such as mines, booby traps and IEDs. Formerly under ISIS command, Jurf Al-Sakhar, a town roughly 60 miles southwest of Baghdad, was found to have around 3,000 mines

	Refugees	IDPs	Asylum seekers in EU in the 4th Q of 2015
Turkey	1,587,374		
Afghanistan	300,423	805,409	79,300
Iraq	271,143	3,596,356	53,600
South Sudan	248,152	1,645,392	
Syria	149,140	7,632,500	145,100

Table 1. Per U.N. Commissioner for Refugees and the European Commission, 3 March 2016. http://bit.ly/1XaQQ2F.
Courtesy of Eurostat Statistics Explained.

Domiz camp in Dohuk, Iraqi Kurdistan, is the temporary home to more than 16,000 Kurdish Syrians.
Photo courtesy of IRIN.

when the Iraq army reclaimed the territory.[7] ISIS also proves to be a formidable enemy and danger to refugees in the Middle East because of their ability to adapt and reinvent these explosive devices. Moreover, the transnational insurgency group is committed to deploying vast amounts of nuisance mines, which are harder to locate, mark and clear as they are not deployed for military tactical purposes but are laid haphazardly and at random.[8] ISIS leverages its advantage of territory, facilities, financing and technical knowledge to adapt.[9] According to the Kurdish fighters who battle ISIS, the group left thousands of mines in their wake as they fled the Syrian city of Hasakah. There are so many mines, in fact, that at least 15 villages around Hasakah are uninhabitable; Kurdish fighters simply do not have the technology or skills to conduct mine clearance. A commander in the army stated that 15 of his fighters were killed in the last four months while attempting to defuse mines.[10] Additionally, Iraqi forces took the city of Anbar back from ISIS control in December 2015. However, ISIS "used 'improvised explosive devices' to booby trap roads, buildings, pylons, bridges and river banks, and placed snipers in high positions as it seeks to hamper the progress of its enemies in Ramadi."[11] Since December 2015 and as a result of these tactics, roughly 20 civilians were killed and many others injured by IEDs while trying to flee. Looking at Iraq as a whole, there are currently 3.3 million IDPs in 3,500 sites across the country, according to statistics issued by the U.N. mission in Iraq in March 2016.[11]

Fighting not involving ISIS continues to occur throughout Iraq but especially around the city of Ramadi. According to Iraq's Ministry of Displacement and Migration, thousands of Iraqi citizens fled from the fighting between the army and Daesh militants around the city. The Iraqi army previously reclaimed the city from Daesh militants in December 2015, and the government is clearing the city of UXO before IDPs can safely return.[12]

These obstacles demonstrate the critical danger citizens face even after they return home. According to MAG (Mines Advisory Group), approximately 110,000 Syrian refugees have fled to Iraq. The majority live near the Domiz Refugee camp, which is located next to a former military base and is heavily contaminated with mines and UXO.[13] Since the late 1980s, mines have victimized more than 29,000 people across Iraq, with more than 14,000 of those casualties occurring in the Kurdistan region. This is an immediate issue, as the majority of refugees are currently living in this region.[14] In addition, minefields remain along the borders of Iran, Saudi Arabia, Syria and Turkey, as well as along the internal former Green Line separating the Kurdistan region from central and

Country	Number of casualties
Afghanistan	**1,296**
Colombia	**286**
Myanmar	251
Pakistan	233
Syria	**174**
Cambodia	**154**
Mali	**144**

Table 2. Bolded countries ratified the *Anti-Personnel Mine Ban Convention*, per the *Landmine and Cluster Munition Monitor*, November 2015. http://bit.ly/24AqYwL.
Table courtesy of the Landmine and Cluster Munition Monitor.

southern Iraq. As a result of the massive amount of mines, refugee movement in Iraq is heavily restricted. Table 2 lists countries with more than 100 reported ERW casualties in 2014.

The Middle East

Since the Syrian Civil War began, people in increasing numbers have fled the country for Europe and North America in search of a better quality of life. To date, at least 1.6 million Syrians have sought refuge in Turkey, and the Turkish government has already spent nearly US$4 billion in response. Their path across the border into Turkey is littered with UXO, greatly increasing risk of injury or death. Human Rights Watch (HRW) reports that Turkey laid almost 615,500 mines along its border with Syria to prevent illegal border crossings between 1957 and 1998. HRW states that a restricted zone along the Turkey-Syria border threatens thousands of Syrian refugees with a high number of mines.[15] Despite the Turkish General Assembly passing a bill in February 2015 to clear the majority of those mines, refugees continue to be killed and injured as they try to escape from Syria.[16] A renewed effort by the Turkish government may make a huge difference in procuring safety for migrants fleeing Syria. According to Turkish Defense Minister Ismet Yilmaz, more than 222,000 mines will be cleared, and the country aims to conclude clearance operations by 2022.[17] Civilians are not the only ones who are at serious risk from mines. According to ARA News from 16 March 2016, at least five Kurdish YPG (People's Protection Units) fighters were killed and 20 or more wounded in a mine explosion planted by ISIS prior to their departure from Shaddadi city in Syria's northeastern Hasakah province.[18]

The current number of Syrian refugees is simply staggering. According to the UNHCR, there are 4,813,993 registered Syrian refugees as of 16 March 2016, with 2.1 million residing in Egypt, Iraq, Jordan and Lebanon. Another 1.9 million refugees are in Turkey and more than 28,000 in North Africa. The refugees are 49.3 percent male, 50.7 percent female, with the largest demographic being those between the ages of 18 (21.5 percent) and 59 (24 percent). Between April 2011 and January 2016, there have been 935,008 Syrian asylum applications in Europe.[19]

Despite having an economy that comprises less than 0.001 percent of the U.S. and E.U. economies, Jordan has accepted at least 60 times the number of Syrian refugees as France and 250 times the number of refugees as Italy. Based on the latest figures from the UNHCR, there are 630,000 Syrian refugees registered in Jordan.[19] With so many migrants and refugees, Jordan is having an extremely difficult time keeping up with the increasing numbers. According to Amnesty International, 58 percent of Syrians in Jordan who have chronic health conditions lack access to medications or other health services.[20] This is a serious issue because these refugees rely heavily on the health services provided by Jordan. Lebanon, too, is bearing the brunt of the protracted violence in Syria. According to Al Arabiya, the number of Syrian refugees in Lebanon is more than a quarter of the country's own population, and Lebanon is hosting at least 1.2 million refugees.[21]

IDPs and refugees are concurrently vulnerable to landmine devastation. Presently the 7,632,500 IDPs in Syria are threatened by mines and UXO. Furthermore, roughly 6.5 million of those IDPs are in need of serious humanitarian assistance in the wake of the ongoing conflict according to the United Nations.[22] In 2012, Syrian troops reportedly planted mines along routes used by IDPs trying to flee the country.[23] ISIS has similarly added to the danger by leaving mines and UXO in Christian civilian homes. As a result, civilians returning to their homes are faced with underground devices that can be triggered by something as simple as a bicycle or a child's footsteps.[24]

Europe

Even after reaching Europe, refugee populations are not safe from the devastating effects of mines. Croatia and Hungary recently closed their borders to refugees, forcing them to follow a new path from Albania, Bosnia and Herzegovina, and Montenegro. Left over from the Yugoslav Wars of the 1990s, Bosnia and Herzegovina has 1,417 minefields across 1,165 kilometers of territory.[25] The flooding that plagued the country in 2014 is another issue compounding the country's mine contamination. Many mines have shifted to new areas, calling for emergency marking in many of the flooded areas.[26] Prior to the border closing, the majority of refugees could safely cross through Hungary on the way to their final destination, most

The Za'atari refugee camp for Syrians in Jordan, November 2013.
Photo courtesy of CISR.

often Germany or a Scandinavian country. Like Bosnia and Herzegovina, Croatia is rife with mines and UXO. There are an estimated 50,000 mines in the ground, and 198 people have died in Croatia from UXO since 1996.[27] Mines are dispersed across 10 counties and contaminate at least 77 towns and municipalities. Greece is a popular entry point for Middle Eastern and African refugees, and faces many of the same problems as Croatia. Despite reporting in 2011 that it cleared UXO from large amounts of land, a military official noted that residual contamination could still exist in multiple other areas of the country.[27] The *Landmine and Cluster Munition Monitor* reports that a majority of these existing mines date back to the Greek civil war (1947–1949). Similar to Turkey, mines planted at least 50 years ago still pose a threat and cause long-term damage to refugee populations.[28] In 2016, Greece has seen 149,208 arrivals by sea according to the UNHCR. Additionally, 91 percent of those come from countries where refugees are extremely prevalent.[29] Even after reaching their final destination, mine victims face great obstacles and challenges that limit their ability to thrive. In many cases, refugee mine survivors lack official recognition as refugees, mine victims or war victims, and do not achieve citizenship status. Displaced persons with disabilities routinely face insufficient and unequal access to housing, education, healthcare and rehabilitation within the refugee camps.[30]

Africa

South Sudan is heavily mined, which threatens the respective IDP population. The Southern Sudan People's Liberation Army (SPLA) and the Sudan national army planted the vast majority of the mines and UXO during a 21-year civil war that ended in 2005 with the signing of the Comprehensive Peace Agreement. The most contaminated areas include the States of Central Equatoria, Eastern Equatoria, Upper Nile, and Jonglei. Currently, there are 225,286 South Sudanese refugees in Ethiopia, many of whom had to cross these states to secure safety. Thirty-four percent of casualties from mines occurred in Upper Nile State, emphasizing the danger and risks refugees and IDPs take. The government of South Sudan implemented a National Mine Action Strategic Plan, creating a decentralized and rapid explosive ordnance disposal (EOD) response capacity within the army and the police forces in order to address residual mine and ERW contamination long term.[31]

Other African nations are also currently plagued by mines and their debilitating effects. Notably, Angola has a substantial amount of mine contamination following its long civil war (1975–2002). According to the Global Development Research Group, approximately 2.2 million citizens that live on 75 percent of the territory in Angola are threatened by UXO.[32] Particularly hampered by UXO, the province of Moxico is one of the most contaminated and poorest regions, yet the area has seen 8,000 refugees return since 2014. This

More than half of the refugees at Islahiya camp in southern Turkey are children and teenagers.
Photo courtesy of IRIN.

group is at serious risk of injury or death from mines and cannot safely farm their land; the effect on the country's agriculture is significant. For the most part, Angolan farmers can no longer produce coffee, sugarcane, cotton or bananas, forcing the vast majority of the rural population to live below the poverty line.[33] Despite the work of organizations such as The HALO Trust, which has destroyed more than 21,300 mines, thousands of Angolan residents have been killed or injured.[34]

According to the United Nations, the Democratic Republic of the Congo (DRC) has roughly 120,000 refugees and over 2 million IDPs, all of whom are threatened by the presence of mines.[35] There are a substantial number of mines in the Kabalo territory, which was heavily mined during the civil war between 1998 and 2003. A 2011 Mine Action report notes that the large-scale movement of IDPs and refugees trying to return home are threatened by these mines.[36] In 2014, 47 people died from mines and there have been a total of 2,540 mine victims in the DRC. There are at least 130 suspected hazardous areas (SHA) and five are suspected to be impacted. At least 130 SHAs are affected by mines, and five areas are impacted by submunitions.[37] Somalia is equally littered with UXO. The eastern Somalia-Ethiopia border area is heavily contaminated with mines that were laid during the 1977 border war. According to the United Nations Mine Action Service (UNMAS), AP mines have caused only four percent of deaths and injuries in Somalia during 2011. In contrast, UXO represents 55 percent of casualties, thus highlighting the severity of the mine issue at present. Some of the effects of the mine proliferation in Somalia are similar to those in Angola, most notably a reduced availability for both livestock and agricultural production. Fortunately, according to the United Nations, the mine issue in Somalia could be resolved within a ten-year period if given proper attention.[38]

Southeast Asia

Years of protracted violence in Southeast Asia has led to a landmine crisis that is currently being dealt with by both local governments and international agencies. Myanmar is particularly vulnerable. According to the Danish Refugee Council (DRC) and Danish Demining Group (DDG), in Kachin State, IDPs makeup nearly half of all mine casualties.[39] In fact, there were 3,450 recorded civilian casualties in Myanmar between 1999 and 2013.[40] Myanmar has a significant amount of IDPs resulting from more than 50 years of fighting between ethnic non-state armed groups. By the end of 2013, there were 640,900 IDPs based on U.N. agency figures.[41] Many of the mines are located in Karen State where the Karen ethnic rebels have fought against the Myanmar government for over 50 years. Due to lack of adequate healthcare, many mine survivors travel across the Thailand border to receive treatment.[42]

Sri Lanka is another nation facing landmine problems. The 25-year civil war between the government and the Liberation Tigers of Tamil Eelam (LTTE) ended in 2009, displacing 300,000 people. In addition, the conflict left the country's northern and eastern districts heavily contaminated by UXO. This has prevented many IDPs from returning and rebuilding their lives. As of 2012, more than 467,500 IDPs returned to the north and east; however, many are resettling beyond the areas that were cleared of mines, thus remaining in critical danger.[43] Victim-activated IEDs pose a tremendous risk to refugees, IDPs, migrants and civilians.

Conclusion

Regardless of the reasons for migration, IDP and refugee populations are at a heightened risk of injury or death from mines, IEDs and UXO for several reasons. First, the vast majority are civilians who are typically unaware of the life-threatening dangers that mines, IEDs and UXO pose. Second, many of the refugees, IDPs and migrants cross unfamiliar territory in order to reach their destinations. The terrain is often difficult, and mines may be strategically located in the areas most frequented by IDPs. As such, they do not know where mines were deployed, IEDs utilized, or the location of UXO blinds or stockpiles.[44]

These populations are moving, which places them at a much greater risk than if they were sedentary. The movement of refugees, IDPs and migrants is currently occuring in war or conflict zones such as Afghanistan, Iraq, South Sudan and Syria.

- Victim-activated IEDs caused almost two-thirds of all Afghan casualties in 2014.
- 809 IED casualties were reported in Afghanistan in 2014 as compared to 557 IED casualties in 2013.
- Victim-activated IEDs, including homemade mines and booby-traps, were found throughout Kobani, Syria, in 2015.
    - At least 40 deaths and significantly more injuries caused by these mines were reported in the first quarter of 2015 in the villages surrounding Kobani.
- In 2015, IEDs were reported to be the leading cause of death among the 750 Kurdish Peshmerga forces in Iraq killed between June 2014 and January 2015.[45]

Until stability is achieved, the number of deaths due to UXO and mines will continue to rise. The armed conflicts are destabilizing these countries and hindering the ability of governments and international humanitarian organizations to implement and execute plans for mine eradication effectively. With the help of international humanitarian law and international human rights law, states have started to recognize and commit to addressing the needs of displaced persons as well as mine victims.[46] Ensuring the future success of programs will require focused and cooperative dialogue among national governments, in-country factions and outside organizations.

See endnotes page 66

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Field Notes

Finding Legacy Minefields in the Jordan Valley

by Jamal Odibat [Jordan's National Committee for Demining and Rehabilitation]

Due to the many difficulties in accurately determining the location of legacy minefields, demining personnel need traditional and sometimes improvised methods for locating and verifying contamination. With a unique combination of terrain, vegetation, water resources and soil types, the Jordan Valley requires specialized minefield survey and clearance methods to avoid harming the environment.

Regarded as the main source of Jordan's food security, the Jordan Valley's climate allows the country to export large amounts of fruit and vegetables year round, and has great potential for further agricultural and economic development. However, the Royal Engineering Corps cleared an estimated 150,000 landmines between 1993 and 2008. In the past few years, most mine-related accidents in the region took place in areas that were previously believed to be free of mines or in areas adjacent to former minefields.[1] After clearance operations concluded in 2008, mines continued to kill or injure civilians, not only posing a serious risk to human security but also blocking millions of dollars' worth of investments in the region.

Flooding moved this mine away from its original position in the minefield.
All photos courtesy of NCDR.

In August 2008, the National Committee for Demining and Rehabilitation (NCDR) assessed the clearance reports and conducted local community impact surveys to determine whether mines might have shifted due to flooding or erosion and how this risk was impacting their livelihoods. Following the review of records of legacy minefields and clearance efforts, it was determined that there is still considerable risk to the local population. Results indicated that an estimated 15 percent of the 150,000 mines laid remain unaccounted for.[1] To eliminate the risk that these remaining mines posed, NCDR planned and implemented a new Missing Mine Drill process.

Missing Mine Drill

Using this new process, project activities include post-clearance sampling and verification on demined sites employing manual and mechanical teams according to the International Mine Action Standards (IMAS) and the National Technical Standards and Guidelines. This type of sampling both identifies the level of risk in cleared sites and defines the fade-out area to be considered in the operational work plan for each task. Land release procedures for handing over land cleared or released as being verified and safe are applied accordingly.[2] One of the main challenges was to accurately determine the location of the old minefields and its mine belts.

Challenges

Based on NCDR's experience in the field, some of the greatest challenges faced by demining personnel in determining the exact location of old minefields include the following:

- **Flooding** from the Jordan River leads to the displacement of remaining mines and disturbs the minefield marks, often rendering them inaccurate and useless.
- **Vague sketches** of legacy minefields in the Jordan Valley do not provide comprehensive information on current minefield locations. Coordinates using the old mapping system represented an area of one or more

Thick vegetation in the minefield, Jordan River Valley.

square kilometers, whereas actual minefields are hundreds of square meters wide. By using rough approximations and vague sketch marks to indicate topographical features, existing minefield sketches could potentially match multiple locations in the surrounding areas.

- **Thick vegetation** in contaminated areas makes identifying landmarks or the nature of the terrain very difficult. This is made worse by the vegetation that has grown in the minefields over the years.

Solutions

Due to the difficult and dangerous nature of demining in the Jordan Valley, NCDR must compile all available information in order to identify the exact locations of the minefields. To do this, NCDR will conduct field research such as interviewing the local people about their knowledge of existing mines and searching for signs of a minefield, (i.e., barbed wire, fence pickets and any explosive remnants). NCDR will also examine and redraw sketches and documents of the original minefield. In particular, NCDR will use past military movement in the Jordan Valley to determine where militaries would have found it most effective to lay mines. After this process, NCDR will redraw the original minefield on the ground and study suspicious locations again. Once NCDR has sufficient information on the locations of these landmines, the sampling and verification process can begin.

See endnotes page 67

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R&D

Research and Development

The Research and Development section is funded by the U.S. Department of Defense, Unexploded Ordnance Center of Excellence (UXOCOE)

FLAIL TECHNOLOGY IN DEMINING

by Ashish Juneja [Indian Institute of Technology Bombay]

With the use of rollers, tillers and chain flails, the focus of minefield clearance has shifted since the early 1980's from military to humanitarian demining. These machines can clear 200–300 mm of soil depending on the speed of the vehicle and its configuration, the soil type and the terrain. As seen in Figure 1, a 200 mm depth can be cleared if the vehicle operates at 0.5 kph. Unfortunately, heavy machines are difficult to operate at these slow speeds unless large amounts of power are available to run and rotate the flails.[1] Moreover, recent literature cites the use of modern technology in demining (e.g., infrared imaging, ground penetration radar, thermal neutron activation and X-ray tomography). Mechanical machines, however, are still considered the safest tool for clearing minefields.

Figure 2. The Pearson mine roller.
Photo courtesy of Pearson Engineering.

DEMINING MACHINES

Demining machines clear minefields by activating or outright destroying landmines. These are all-terrain vehicles, transportable and (partially) resistant to mine blasts.[2] A large, steel-wheeled roller is a simple demining machine and uses the static load of its wheels to activate mines. Occasionally, a cam or a spring triggered impacting tool is added to the roller to hammer the ground. However, these machines are not effective for all ground conditions.[3] Figure 2 shows a photograph of the Pearson mine roller.

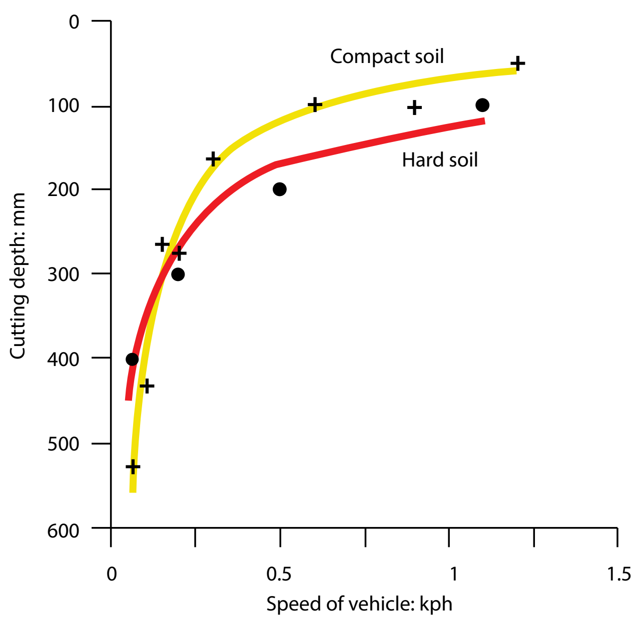

Figure 1. Typical relationship between speed and cutting depth of a light to medium demining machine in two different soil conditions.
Figure courtesy of author.

Figure 3. The Keiler mine flail.
Photo courtesy of Rheinmetall.

Figure 4. The MineWolf tiller.
Photo courtesy of MineWolf.

Parameters	Light	Medium	Heavy
Mine clearing capability	AP and AT	AP and AT	AP and AT
Clearing/neutralizing mechanism specification	31 to 108 chains	48 to 72 chains	1 to 2 flail systems
Clearance width (mm)	1,100 to 2,100	2,000 to 3,500	2,700 to 4,000
Clearance depth (mm)	50 to 100	100 to 200	up to 300
Clearance rate (m2/h)	3,,700	highly variable	140 to 8000
Mode of motion	Both track and wheel	Tracks most common	Track and wheel
Mass of machine (kg)	2,500 to 7,000	7,800 to 18,000	32,000 to 35,500
Mass of flail unit (kg)	unknown	1,500 to 4,300	8,300 to 19,900
Fuel requirement (l/h)	7 to 35	9 to 60	17 to 80
Maneuverability	Very maneuverable	Fairly good, limited with increased size	Limited to heavy and bulky
Transportability	By trailer/air or self-propelled	By trailer or self-propelled	Need low-bed trailer
Control	Remote	Operator controlled and remote	Operator controlled

Table 1. Light, medium and heavy demining machines.[4]
All tables courtesy of author.

Flails and tillers are the most common mechanical demining machines. With flails, attached chains with hammers are rotated using a horizontal shaft, and the hammers impact or dig through the ground. While a large amount of dust and debris can be generated during flailing, this action results in detonation or fragmentation of near-surface mines. The rotation of the shaft is adjusted to optimize the digging depth. Results can improve if the chain-links are replaced by single or multi-lever links. Figure 3 shows the Keiler flail machine.

Tillers function similar to the flail systems. They use a rotating drum fitted with hardened chisels or teeth on its circumference to help dig or bite through the ground. The length of the chisel controls the clearance depth. A flexible knee joint helps increase the degree of freedom of the chisels and absorb most shocks. However, by doing so, the productivity of the tillers is reduced. Tillers use large, powerful engines and tend to be heavy and difficult to maneuver. Tillers can be coupled with flails to destroy mines more reliably. They have been used in Bosnia and Herzegovina and Croatia. Figure 4 shows the MineWolf tiller machine.

Figure 5. Types of hammers used in chain flails.
Figure courtesy of author.

CLASSIFICATION

Depending on their weight, demining machines are classified as light, medium or heavy.[4] Light machines weigh less than 5 tons, are remotely operated and can clear 100 mm thick soil. The MV-4 and Bozena (Series 1–4) are examples of light demining machines. Medium demining machines weigh up to 20 tons and are either remotely controlled or directly operated from its cabin. These machines can clear 200 mm thick soil layers. The RM-KA-01 and -02, Samson-300 and Hydrema-910 MCV are examples of medium demining machines. Heavy demining machines weigh more than 20 tons, use construction or military equipment as their under structure and are operated directly from the cabin. Some heavy machines can be equipped with double flails layers. Heavy machines can achieve a digging depth of over 200 mm. The Rhino-2, Zeus-1, Oracle and Scanjack-3500 are examples of heavy demining machines. Table 1 summarizes the significant differences between the light, medium and heavy demining machines. Tires of many light and medium machines are filled with foam or water to help absorb shock and to protect the vehicle in case of detonation. Heavy vehicles have an armor shield and a double floorboard to protect the vehicle and its operator. Table 2 (next page) summarizes the demining equipment. As the table shows, not all commercially available machines are suitable for every anticipated minefield condition.

FLAIL SYSTEM DESIGN

The magnitude of the impact force and the power required by the flails depends upon:

- The forward speed of the vehicle
- The chain configuration
- The rotational speed
- The depth of penetration
- The impact angle
- The soil type.

At slow speeds, the footprints of the hammers overlap one another as they strike and cut through the soil. However, skip zones will occur if the vehicle moves at a fast speed. At high vehicle speeds, the chains are no longer straight and tend to drag or wobble along the ground. The volume of the soil cut depends on the shape and size of the digging tool. Hammers with sharp geometry increase the penetration and movement through the soil. They also produce erratic impacts. On the other hand, smooth and spherical hammers produce consistent impact.

The energy of the chain flail is calculated using the length and mass of the rotating assembly, and its angular velocity. The repeated impact transfers this energy to the ground. When the hammers impact, the vertical stress distribution in the ground is estimated using Boussinesq's Equation, which is written as

Eq.1 $$\sigma_z = \left[\frac{3Q}{2\pi z^2}\right]\left[\frac{z}{\left(r^2 + z^2\right)^{\frac{1}{2}}}\right]^5$$

where σ_z is the vertical stress at depth z and radial distance r, and Q is the load at impact. Variable σ_z is calculated by assuming that the soil is elastic, homogeneous and isotropic. In reality though, most soils are non-elastic, heterogeneous and contain stones or plant roots, all of which can cause the hammers to wobble or meander over the ground. The problem is further complicated by the fact that the chain flails not only hit the ground but also cut through it. The energy demand to cut or shear through the ground can be very high. The effect of all these stresses cannot readily be incorporated within the framework of Equation 1. However, the results do permit a semi-empirical relation to be fitted to account for the state and consistency of the soil. The Equation is modified as

Eq.2 $$\sigma_z = \left[\frac{kQ}{2\pi z^2}\right]\left[\frac{z}{\left(r^2 + z^2\right)^{\frac{1}{2}}}\right]^{k+2}$$

where k is a soil dependent constant. Table 3 shows the value of k for different soils. Some researchers relate the soil condition to the coefficient of restitution, C_R defined as

$$C_R = \frac{v}{u}$$ Eq.3

where v is the velocity of the hammer after the impact and u is the velocity of the hammer before the impact.[5] Variable C_R of zero implies that the entire energy is transferred to the ground. C_R is greater than one if the hammer hits and explodes a landmine, to release large energy. In the usual case, C_R varies between 0.3 and 0.7, because part of the energy is utilized to cut through the soil.

Deming machines are subjected to wear and tear, and harsh environments, which limits the use of complex and expensive

	Dok-Ing MV-4	Bozena 04	Minemill MC-2004	Bozena 05	RM-KA-02	Aardvark Mark-4	Hydrema 910 MCV-02	Dok-Ing MV-10	Mine-Wolf	Mine-Wolf	Rhino-02
Engine make	Perkins 1106C-E60TA	Deutz BF 4L913	Iveco turbo engine	Tatra T3A-928-30	Perkins 1306-9T	New Holland TM165-T	-	-	Deutz engine	Perkins 3012-26TA3	-
Power kW	129	98	190	170	168	121	272	-	270	663	656
Weight (tonnes)	5.6	6	9.6	11.4	12.5	15.2	18	18	21.8	33.5	58
Clearing speed kmph	0.5 to 2	-	-	-	0.3 to 0.9	0.2 to 1.1	1.4	3	0.8 to 1.5	2	1.3
Clearing width (mm)	1,725	2,225	2,000	2,810	2,000	3,500	3,500	-	2,800	3,400	3,000
Clearing depth flail (mm)	200	250	250	300	300	250	200	350	150	300	250
Chain length (m)	410	-	-	-	450	-	1100	-	1210	1000	-
Number of flails	-	-	67	-	36	-	72	-	-	82	-
Clearing depth tiller (mm)	-	-	-	-	-	-	-	390	350	400	300
Rotating speed typical (rpm)	900	400	500	500	600	300	440	-	-	-	400
Performance m2/hour	500 to 2,000	520 to 2,500	1,400 to 2,000	1,050 to 4,900	500 to 2,000	-	-	-	2,800	5,000	750 to 2,500
Fuel consumption (l/hour)	15 to 25	-	-	-	35 to 40	23	-	30 to 70	42	40 to 80	60 to 110

Table 2. Summary of the demining equipment. Note that "-" indicated data is unavailable or inapplicable.

Soil condition	k
Elastic	3
Overconsolidated/hard soil	4
Slightly overconsolidated/dry soil	5
Normally consolidated/soft soil	6

Table 3. The relation between soil condition and k (soil dependent constant).

equipment in most demining applications. Speed of the demining machine affects the quality of the demining operation. Although a slow machine increases productivity cost, its chain flails will not miss any areas, and the entire ground is cut during the impact process. The load at impact should detonate or fragment any mine within its zone of influence.

Large amounts of power are required to rotate the flails and propel the vehicle. This requirement increases the weight and size of the power-generating equipment. Heavy demining machines require powerful engines to overcome the topography and the soil conditions of any minefield.

EXPERIMENT

With demining equipment, the energy available to cut through the ground depends upon the soil characteristics and the configuration of the rotating chain flails. It may not be difficult to characterize the soils using the principles of mechanics if the gradation, packing and stress history of the geomaterial are known. On the contrary, the flail configuration's effect on the cutting resistance is often hard to perceive because of the complex interaction of the shape, size and rotational speed of the hammers, in addition to its impact angle and penetration depth. Although some of these complexities can be reduced, they cannot be eliminated completely. The objective of this study is to estimate the energy utilized by the chain flails to cut through the soil. Laboratory tests were conducted to investigate the effect of shape and rotational speed of the hammer on the energy transferred to the ground.

Soil beds were prepared in the laboratory using fine sand and clayey silt. Table 4 shows the properties of the two soils used in these tests. As can be seen, both the soils belong to Class I of CEN (European Committee for Standardization) Workshop Agreement (CWA) 15044 classification. In total, 34 test beds were prepared by compacting the soil in a 1270-mm-long, 445-mm-wide, 750-mm-tall, steel container. The samples were compacted in layers at their maximum dry density using a 2.5 kg rammer falling from a height of 300 mm until the container was completely filled.

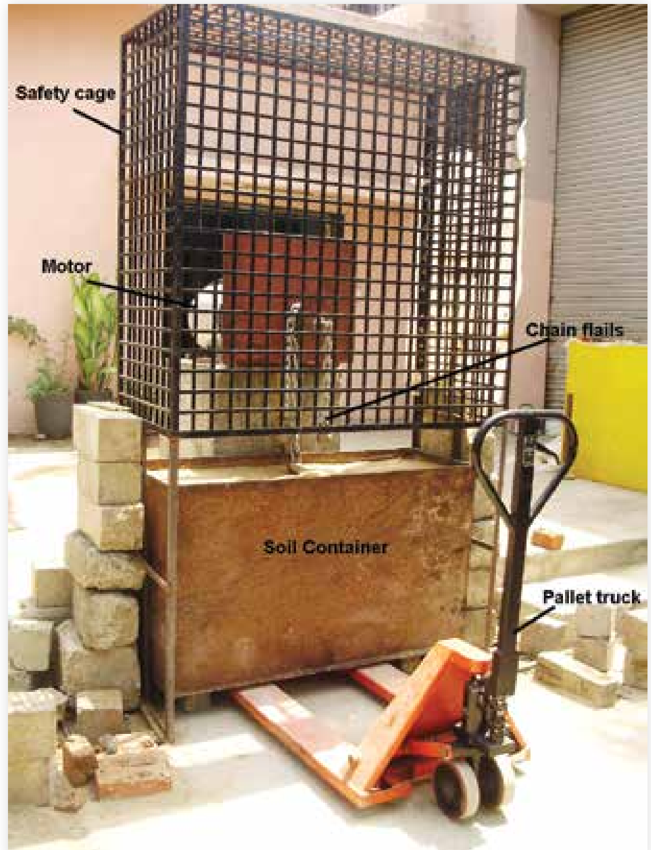

Figure 6. Experiment setup.
Figure courtesy of author.

After sample preparation, the container was carefully placed beneath the flail assembly, fixed to a pedestal. The flailing assembly consisted of three 450-mm-long chains attached at 120 degrees to each other. The chains were rotated by a 415 V, 50 Hz and 20 HP induction motor, which was air-cooled during the tests. The setup was connected to a variable frequency drive to help maintain the motor speed during the flailing operation. The entire flail and motor assembly weighed about 180 kg when placed over the pedestal. Figure 6 shows a photograph of the experimental setup. Also shown in the photograph is the safety cage to enclose the flails during rotation.

Hammers were attached to the free end of the chains. Figure 7 (next page) shows the four different hammers used in the tests.

Soil	Proportion %			Liquid Limit (%)	Plastic Limit (%)	Dry unit weight (kN/m³)	Water content (%)	Shear strength parameters	
	Sand	Silt	Clay					c (kN/m²)	φ (degree)
Fine sand	100	-	-	25	-	15	9	5	31
Clayey silt	19	67	14	30	23	18	12	40	28

Table 4. Soil properties for fine sand and clayey silt.

Figure 7. Hammers used in test.
Figure courtesy of author.


Figure 8. Soil container after test using Mushroom-I hammers in clayey silt.
Figure courtesy of author.

Each hammer weighed about 1 kg and was about 60 to 80 mm in diameter. It was perceived that the above spherical, cylindrical and mushroom shaped hammers would result in different soils resistance. During the test, the soil container was raised by 4 to 7 mm/s using a pallet truck to cut the soil using the three flails rotating at 150 to 550 rpm. In some tests, the pallet truck was replaced by a forklift to lift the soil container. The torque required by the motor to cut through the soil was recorded using an automated data logger. The test was stopped when over 250 mm thick soil was cut. Figure 8 shows a photograph of the soil container after the test.

RESULTS AND ANALYSIS

Figures 9 through 12 (next page), and Figures 13 through 16 (page 60) show the torque versus the depth of cut in fine sand and clayey silt, respectively for the different rotor speeds. As expected, the measured torque in clayey silt was more than that in fine sand tests. The torque increased with the increase in the size of the cut to reach a peak toward the end of the tests. The figures show that Spherical hammers required the largest torque and hence offered the greatest resistance to shear the soil, followed by Mushroom-II hammers. These findings also indicate that T and Mushroom-I hammers are more efficient to cut through the soil without causing a significant spike in the power demand.

Figure 17 (page 61) shows the surface area of the soil bed cut by the flails. In the figure, the area of the circular segment, A_1 is given by

$$A_1 = R^2 \text{Cos}^{-1}\left[\frac{R - x}{R}\right] - (R - x)\left[2Rx - x^2\right]^{1/2} \quad \text{Eq.4}$$

where R is the radius of the chain-flail (equal to 450 mm) and x is the depth of the cut after each revolution. Variable x equals the relative motion between the flails and the soil bed. Because there are two sides of the circular segment, the total surface area of the circular segments is equal to $2A_1$.

Figure 17 also shows the surface area produced by the hammer's width. This area is generated at the base of the arc and is given by

$$A_2 = R\left[2\text{Sin}^{-1}\left(\frac{\sqrt{(x\ 2R - x)}}{R}\right)\right]d \quad \text{Eq.5}$$

where A_2 is the area produced by the hammer along the arch and d is the average diameter of the hammer. Since the overburden is small and insignificant, the effect of the vertical stress component on the shear resistance can be ignored. The cutting resistance or the force to shear through the soil can therefore be written as $F = c[2A_1 + A_2]$ where c is the cohesion component of the shear strength (see Table 4). Eq.6

Figure 18 (page 63) compares the cutting resistance deduced from Equation 6 with Mikulic's equations for loose/soft and compact/stiff deposits.[6] In Figure 18, the depth of the cut, x, is normalized by the length of the chord AB (see Figure 17). As Figure 18 shows, Mikulic's equation tends

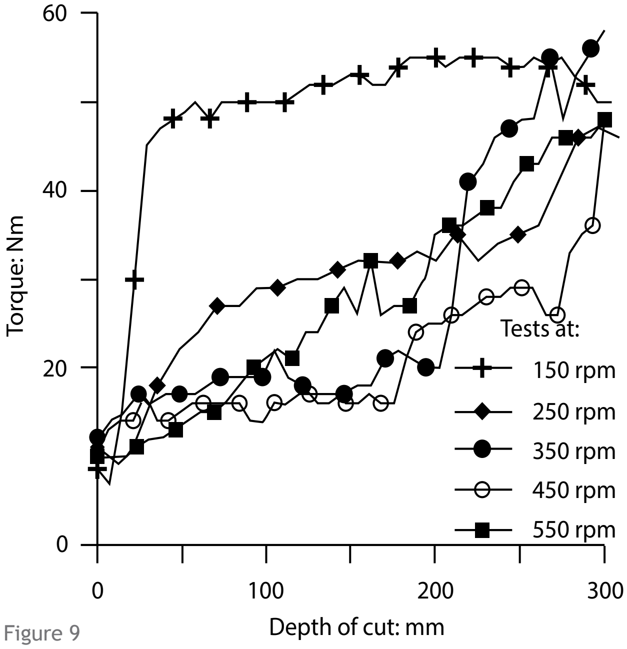

Figure 9

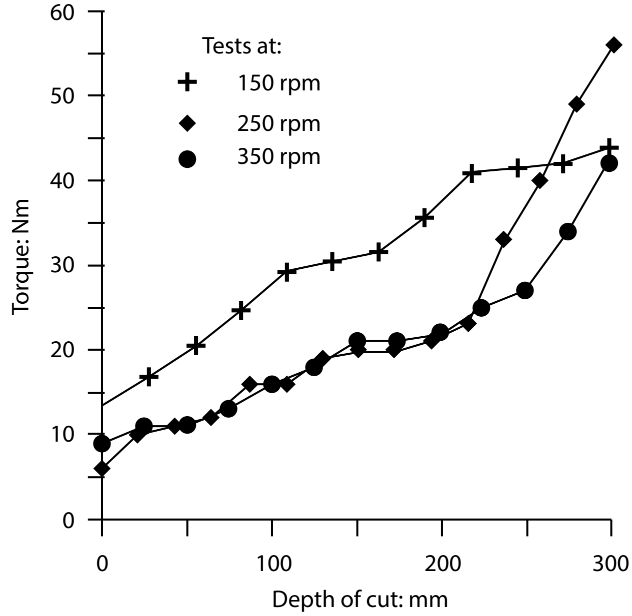

Figure 10

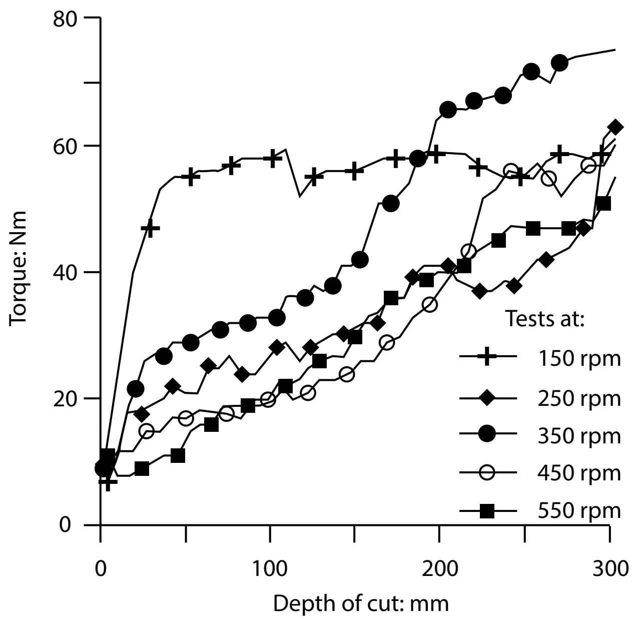

Figure 11

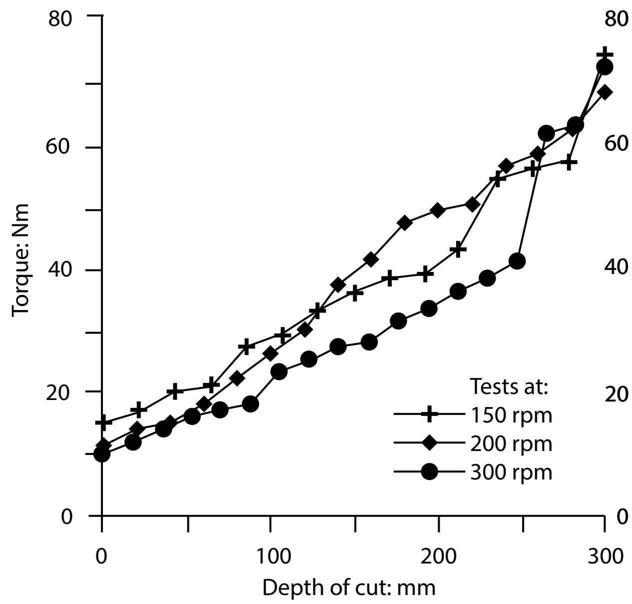

Figure 12

Figures 9–12. Torque versus depth of cut in fine sand using: (a) Spherical hammers, (b) T hammers, (c) Mushroom-I hammers and (d) Mushroom-II hammers.
Figures courtesy of author.

to slightly overpredict the results of both the soils from about mid depth.[6] Some difference between the two predictions also exists at shallow depths in clayey silt. But then, the difference is less than 10% and is considered to be within the acceptable range.

Since the effect of F in Equation 6 is to cut and remove the soil up to the surface, the work done or the energy, E_1 is equal to $E_1 = c[2A_1 + A_2]H$ where H is equal to the depth of the cut (see Figure 17). E_1 will be the maximum (E_1max) when H is equal to 250 mm, and A_1 and A_2 are measured in the last cycle. In addition, the energy to lift the 3 hammers in one revolution, E_2 is written as $E_2 = 6mgR$.

Eq.7

Eq.8

Therefore the maximum torque, T required to cut through the soil bed is equal to

$$T = \frac{E_{1\max} + E_2}{2\pi}$$

Eq.9

Ito and Fujimoto suggested that T in Equation 9 be increased by 15% because of the impact loading.[7] Watanabe and Kusakabe (2013) observed that the increase was not uniform but varied from 0% to 10% under high frequency loads in different soils.[8] Because

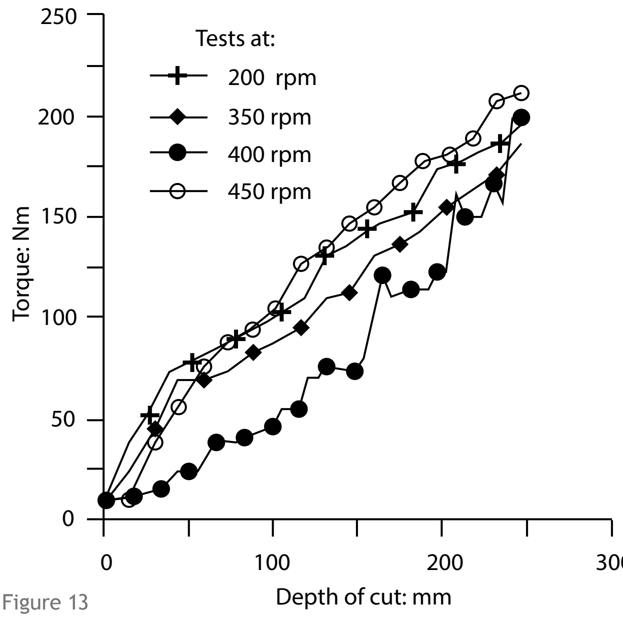

Figure 13

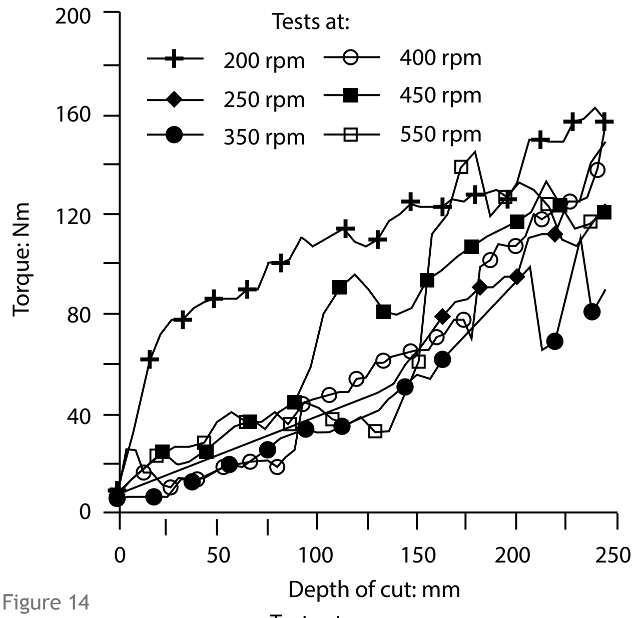

Figure 14

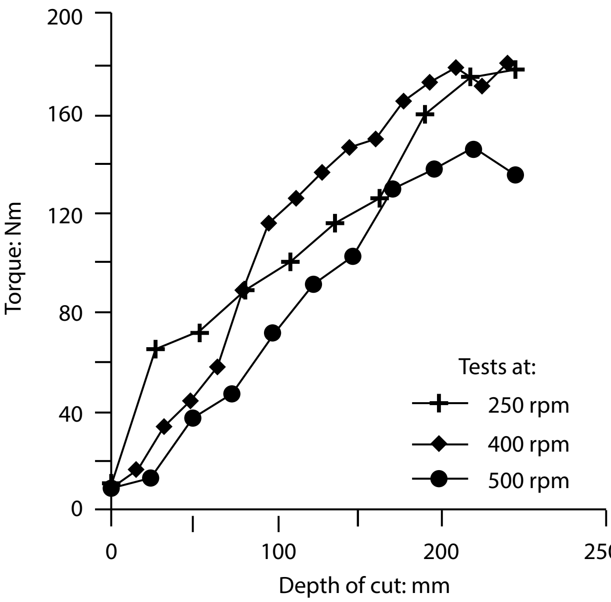

Figure 15

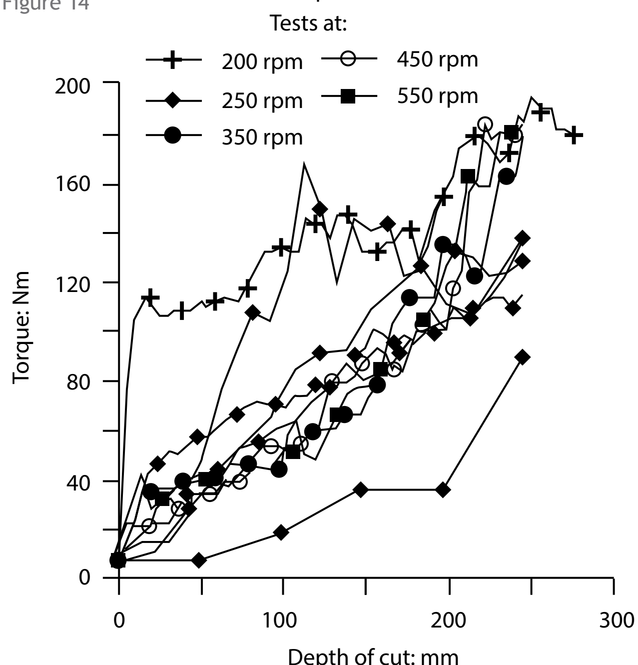

Figure 16

Figures 13-16. Torque versus depth of cut in clayey silt using: (a) Spherical hammers, (b) T hammers, (c) Mushroom-I hammers and (d) Mushroom-II hammers.
Figures courtesy of author.

of the above uncertainties, the torque was varied from 1T to 1.15T in the above Equation. Figures 19 and 20 show the torque calculated using Equation 9 for rotor speed of 150 to 600 rpm. The effect of the impact loading on the calculated torque is shown as a thick blue curve in the two figures. Figures 19 and 20 (page 61) also show the maximum measured torque deduced from Figures 9 through 16 for Spherical, T, Mushroom-I and Mushroom-II hammers. As can be seen, the calculated torque significantly underestimates the measured torque, the difference being more in fine sand tests. Also noteworthy is the scatter in the measured data. While some difference between the measured and calculated torques can be attributed to the effect of the chain and its weight, it still cannot explain the significant spread in the data. Because of low confining pressures, it is also unlikely that the soil particles would have crushed under the impact thereby increasing the measurement.

The difference can be resolved by further adjusting the calculated torque for high frequency loads. However, as Figure 21 suggests, the ratio of the measured and calculated torque is somewhat unaffected by the rotor speed. This imposes a limit on the adjustment, which would otherwise unrealistically model the soil yielding. Unfortunately, this procedure will not help tighten the observed data. One possible reason to explain the discrepancy is

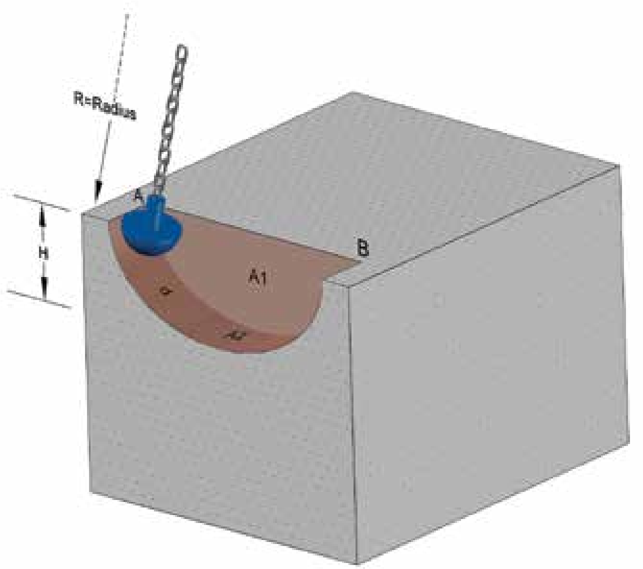

Figure 17. Surface area of the soil bed cut by the flails.
Figure courtesy of author.

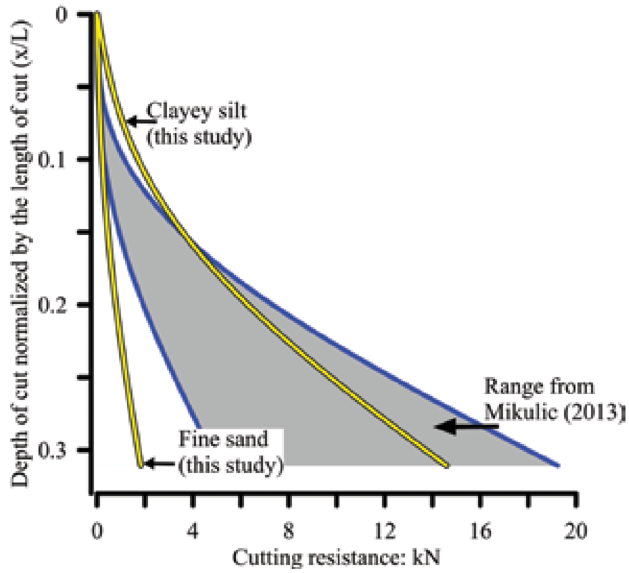

Figure 18. Cutting resistance of the soils.
Figure courtesy of author.

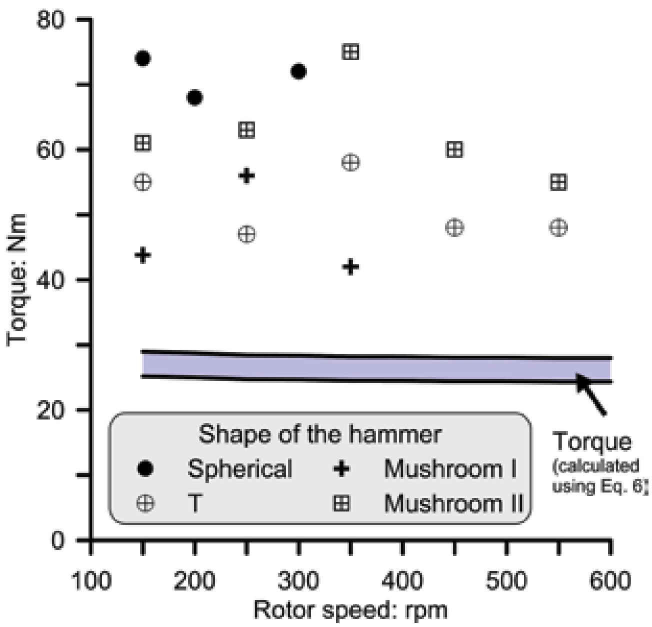

Figure 19. Torque calculated in fine sand.
Figures courtesy of author.

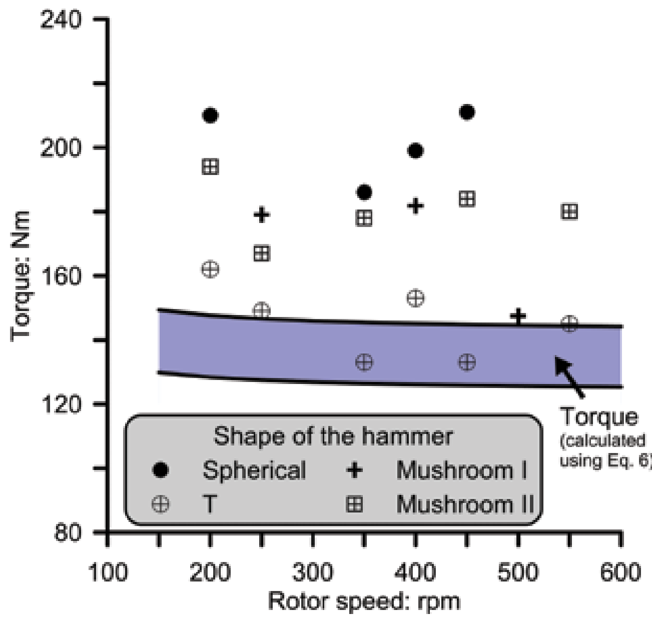

Figure 20. Torque calculated in clayey silt.

that when the soil flows past the hammer during impact, it has a tendency to dilate or expand, resulting in an increased penetration resistance. Dilation can be significantly high in fine sands. The buildup of pressure bulb ahead of the hammer and the tendency of the soil to dilate, depends upon the shape of the hammer. Spherical shapes mobilize significantly high resistance loads compared to shapes that have sharp edges.[9] These effects cannot readily be incorporated in the simple framework but do permit a semi-empirical fit to the measured torque. Equation 9 can now be modified as

Eq.10
$$T = \alpha\left[\frac{E_{1\,max} + E_2}{2\pi}\right]$$

Soil	Hammer	α
Clayey silt	Spherical	1.6
	T	1.2
	Mushroom I	1.3
	Mushroom II	1.4
Fine sand	Spherical	2.9
	T	2.1
	Mushroom I	1.9
	Mushroom II	2.6

Table 5. Parameter α in clayey silt and fine sand.

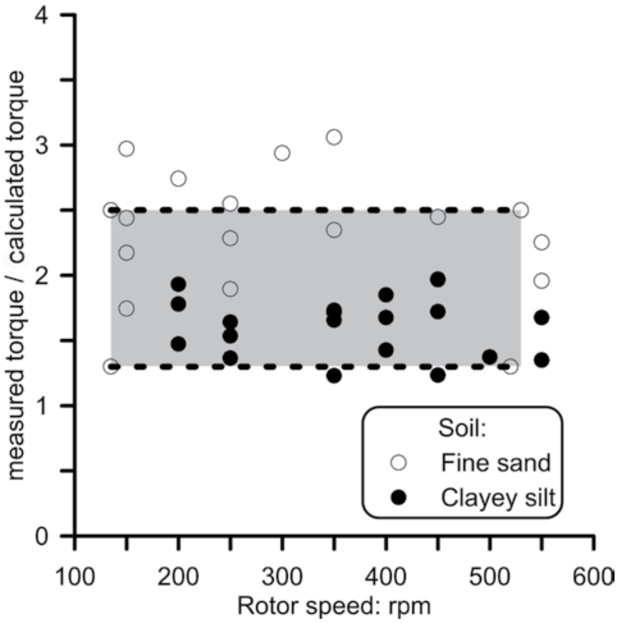

Figure 21. Ratio of measured and calculated torque versus rotor speed.
Figure courtesy of author.

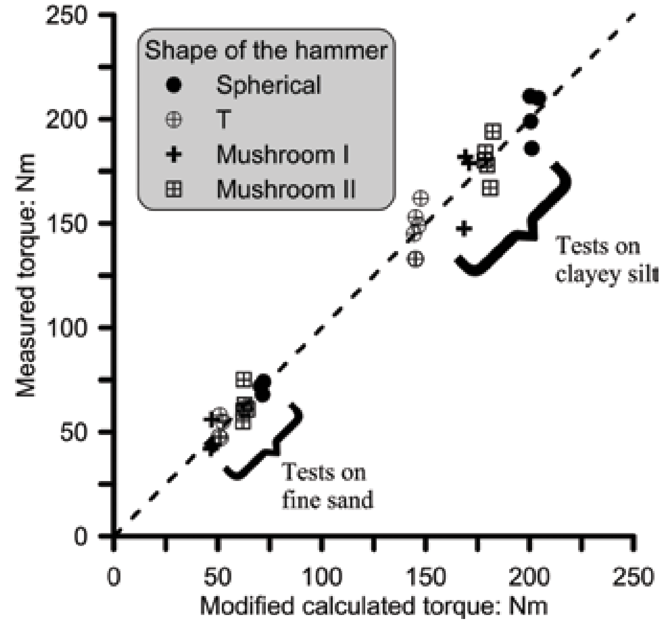

Figure 22. Comparison of the measured torque to the modified calculated torque.
Figure courtesy of author.

where α is a fitted parameter. Table 5 shows the value of α for the four hammers in fine sand and clayey silt.

Figure 22 compares the measured and the modified calculated torques using Equation 10. As can be seen, the measured torque is now reasonably well predicted, indicating that the data can be accommodated within a highly deterministic framework.

CONCLUSION

The discussion presented data relating to the effect of the soil type and the shape of the hammer on the energy transferred to the ground. The results showed that the torque required to flail through clayey silt was about twice to that required in fine sand. Spherical shaped hammers utilized the maximum torque in both the soils. The least resistance was observed with Cylindrical and Mushroom-I shapes. Torque calculated using Mohr Coulomb shear failure criterion underestimated the measured torque. This is partly attributed to the shape and size of the hammer, which cannot readily be incorporated within the above framework. However, the results do permit a semi-empirical relation to be fitted to the data.

See endnotes page 67

The author wishes to thank Dr. B.A. Mir and Dr. Raghunandan M.E. for their help performing the laboratory tests during their teaching assistantship at IIT Bombay. This work was supported by R&DE, Defense Research and Development Organization, Pune, vide project code RDE/91335/CMF/CE. The contents of this paper are solely the responsibility of the author and do not necessarily represent the official views of R&DE, Pune.

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MAXIMIZING THE EFFECTIVENESS OF MOBILE TECHNOLOGY

by Colonel (U.S. Army, retired) Howard M. Rudat [MAPPS, Inc.]

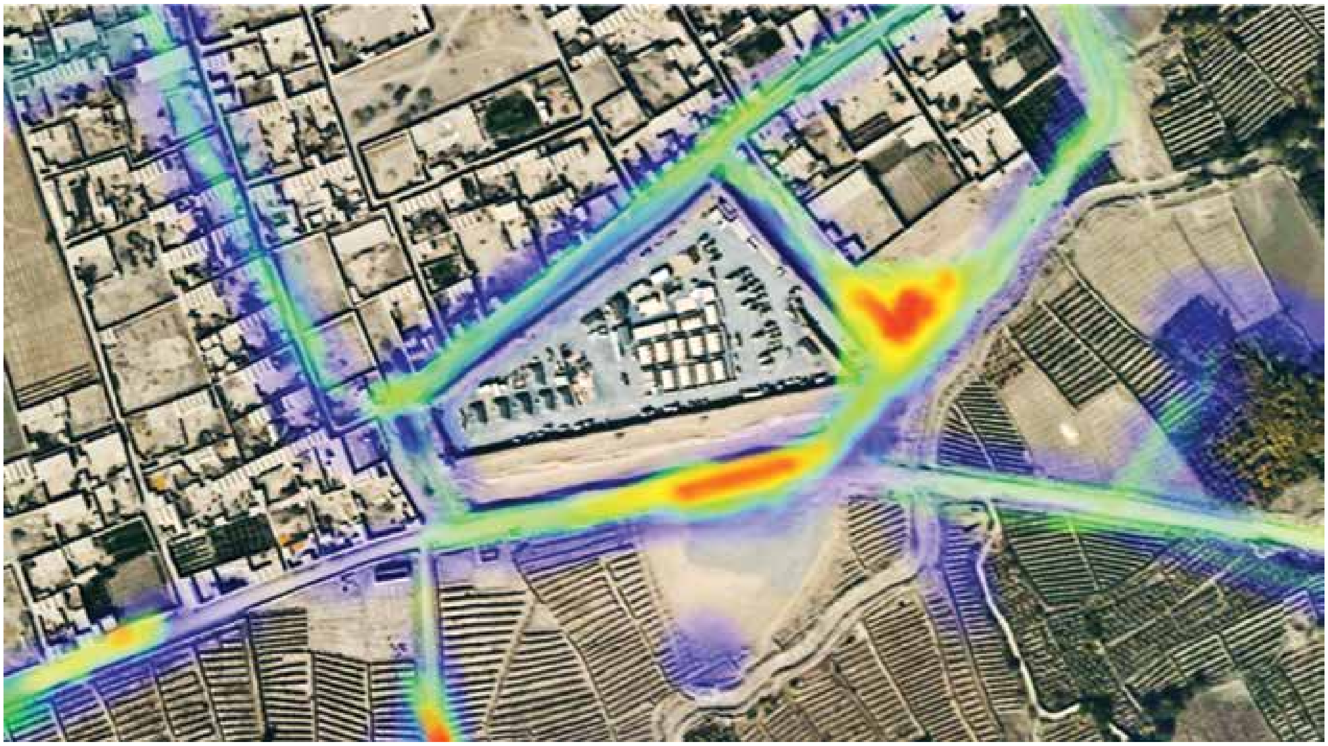

Figure 1. Heatmap depicting areas where project's mobile devices were most frequently located.
All graphics courtesy of the author.

Mobile technology has transformed the way we live our lives and has the potential to dramatically assist in demining. However, commercial off-the-shelf (COTS) systems coupled with explosive remnants of war (ERW) related applications leave capability gaps and create potential risks that must be closed. A more tailored and deliberate ecosystem approach when employing mobile technology will yield greater benefits and avoid the problems encountered when Alexa, Cortana, Google Now or Siri do not provide the necessary information. It seems that at the times when you need information the most, the smart personal assistants provided by Google, Apple and Microsoft either provide you with information that isn't relevant or they don't provide any information because you do not have a strong enough cell signal to ask them a question.

Since 2010, a diverse team of project managers, software developers, system engineers and testers have supported a U.S. Department of Defense program to determine how best to integrate commercial mobile technology into the military. The challenges and successes of the team resulted in over 3,000 soldiers adopting the capability in support of Operation Enduring Freedom.[1] Moreover, the team identified the key attributes necessary to make mobile technology a viable tool for the demining and ERW eradication communities.

Smartphones have made significant impacts in our day-to-day lives. A critical component to the success of this technology is a reliable and robust network that greatly enhances the usability and functionality of these devices while also providing management and security functions from a back-end infrastructure. We frequently see the limitations of standalone devices when we venture into an area with no or degraded service, or place our devices in Airplane mode. Only when we cannot access a map or communicate with others do we fully appreciate the reachback capability as an essential component of mobile technology. These limitations could have catastrophic effects when a device is being used to navigate, maintain situational awareness or develop a common operational picture to support a military operation.

The program identified the need for a full ecosystem approach to mobile technology in order to insure uninterrupted support for our mobile users in Afghanistan. To that end, the ecosystem provides onboard maps (aerial imagery), a customized operating system providing both security and usability enhancements, an integrated framework that allows applications and functions to work seamlessly together and a user-defined, customized suite of applications tailored to the mission, made available through the system's marketplace. When on a network, functionality such as messaging and viewing the location of other personnel using the devices becomes available. Although the added security measures to protect information exchange within the military may not be needed for demining and ERW activities, a system that is 100 percent reliable and tailored for tactical operations is needed.

Figure 2. Common operating picture from the 2015 Boston Marathon.

Small commercial drones equipped with cameras capture high-resolution imagery up to 0.3 mm per pixel, convert it into a mobile friendly format using tiling software to create a mosaic dataset from the imagery tiles and have it available for use on a mobile device in less than five hours. This process involves taking a poorly mapped area and transforming it into a highly accurate, near real time visualized operational area. Using planning software, the team transforms this imagery into a clearly marked area with sweep lanes, restricted areas and any other graphical depictions needed to accomplish the mission. Personnel equipped with mobile devices can also add information, such as mine locations and use the camera, video and audio recording functions of the smartphone to further capture critical information. Devices are fully customizable to allow the inclusion of libraries and databases of information (e.g., the Collaborative ORDnance Data Repository) on mines and other ERW to allow for easy identification as well as training and education purposes.

The scalability of the ecosystem enhances its functionality. Something as simple as an ordnance ID guide in the form of an app to assist the local population in identifying potential hazards could be distributed via hardware provided by a relief or humanitarian organization or uploaded to an individual's personal device. The next level of capability could add a reporting tool for the found ordnance. Using this approach, what would begin as a single capability could grow over time as resources and needs the creation of an entire demining and ERW eradication planning, execution and reporting tool. Regardless of how basic or advanced the tools you employ, the result is the same: a safer environment for the area's residents.

See endnotes page 67

Mobile technology in use in Afghanistan.

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FEATURE

Improvised Explosive Devices (IED) & Pressure Plate IEDs

As the number one cause of military casualties, IEDs are now also becoming one of the greatest threats to civilians. How are traditional humanitarian CWD programs dealing with the increasing prevalence of IEDs and pressure plate IEDs? Recognizing CWD in this context is humanitarian assistance and different from military/security counter-IED efforts, are there lessons learned from clearance in counter-IED activities applicable to the traditional CWD community?

SPECIAL REPORT

Bosnia and Herzegovina 20 Years On

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Of particular interest are: Burma, Cambodia, Laos, Nepal, Thailand and Vietnam.

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