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

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THE JOURNAL

OF ERW AND MINE ACTION

Issue 18.1 | Spring 2014

LAND RELEASE



- › Residual Clearance & EOD
- › Donor Funding
- Plus: Notes from the Field
and Research & Development



The Journal of ERW and Mine Action
Center for International Stabilization and Recovery
at James Madison University
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Issue 18.2 | Summer 2014 (Print and Online)
Focus: CWD Emergency Response
Feature: Sahel-Maghreb
Special Report: SA/LW Marking and Tracing Initiatives

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A mixed gender team of deminers in Laos
Photo courtesy of Ariana Calza Bini

Contributors

Stephen Ahnert	Gen Endo	Douglas Felix Kilama
Håvard Bach	Brenna Feigleson	Erik K. Lauritzen
Alexandra Berkowitz	Suzanne Fiederlein	Mikkel Nedergaard
Ian Biddle	Edwardo F. Fukushima	Fran O'Grady
Arianna Calza Bini	Helen Gray	Samuel Paunila
Erik de Brun	Nyske Janssen	Erica Qualliotine
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Chloe Cunningham	Alex M. Kaneko	Pascal Simon
		Dane Sosniecki

The Journal of ERW and Mine Action is a professional trade journal for the humanitarian mine action and explosive remnants of war (ERW) community. It is a forum for landmine and ERW clearance best practices and methodologies, strategic planning, mine risk education and survivor assistance.

The Journal Editorial Board reviews all articles for content and readability, and it reserves the right to edit accepted articles for readability and space, and reject articles at will.

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Please direct all submissions, queries and subscription/CFP requests to:

Lois Carter Crawford, Editor-in-Chief
Center for International Stabilization & Recovery
James Madison University
800 S. Main Street, MSC 4902
Harrisonburg, VA 22807 / USA
Tel: +1 540 568 2503
Fax: +1 540 568 8176
Email: cisreditor@gmail.com
<http://www.jmu.edu/cisr>



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Photo courtesy of Missouri State University Photo Services

Director's Message

Dear Readers,

As the director of the Center for International Stabilization and Recovery (CISR) at James Madison University, I recently presented at a disaster-management conference in Indonesia, tying disaster management with post-conflict recovery; spoke at the Carnegie Endowment for International Peace's landmine event in Washington, D.C., and traveled to northern Iraq as part of a new CISR risk-education project for Syrian refugees. Travels such as these help CISR to recognize and evaluate humanitarian mine action (HMA) trends, seek authors and ideas for *The Journal*, and discover new ways to help our global community.

In this issue of *The Journal*, our Focus section discusses land release issues. For example, Mikkel Nedergaard (Danish Demining Group) examines how various HMA programs are attempting to develop better ways to monitor and document the socioeconomic results of their programs. Similarly, lessons learned from the development and use of DDG's Impact Monitoring System provide examples of how to build or improve current outcome- and impact-monitoring systems. Norwegian People's Aid's Håvard Bach discusses using technical survey more effectively to reduce unnecessary, time-consuming and costly deployment of mine action resources.

In our Feature section, we look at best practices of residual clearance: Fran O'Grady (Defence Forces Ireland) reviews Irish Army Engineer Corps' efforts to develop a self-sustainable nationwide capacity for conventional munitions disposal in the world's newest nation, South Sudan. Ian Biddle of G4S Ordnance Management Ltd. discusses how the need to dispose of small arms ammunition (SAA) for short-term stability and security has traditionally outweighed the long-term need for environmentally responsible disposal. In addition, two of our authors, Erik K. Lauritzen (Lauritzen Advising) and Samuel Paunila (Geneva International Centre for Humanitarian Demining), look at how lessons learned in one country can be applied to other post-conflict environments.

Finally, this issue's Special Report section focuses on declining donor funding and strategies to attract new donors to unexploded ordnance/mine action programming. CISR's Dane Sosniecki and Suzanne Fiederlein review how the mine action sector is shifting its approach to resource mobilization and allocation, and the importance of seeking diverse financial and technical funding.

As a nonprofit, CISR faces many of these same funding challenges affecting the broader mine action community. Like others, we seek to diversify our funding base; we would love to learn about what has worked for your organization. Please continue to dialogue with us.

Ken Rutherford,
CISR Director



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Meet PM/WRA's New Director Col. (Ret.) Stanley L. Brown

Continuing the funding for conventional weapons destruction programs remains a primary objective for Stan Brown, the new director of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA). This interview introduces the director, provides a snapshot of his past experience and shares his hopes for the future of humanitarian demining.

By Alexandra Berkowitz [CISR]

In July 2013, Stanley (Stan) L. Brown was appointed director of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) replacing outgoing director, James (Jim) Lawrence. Having served in the U.S. Air Force and in the State Department's Office of the Coordinator for Counterterrorism (now Bureau of Counterterrorism), Brown intends to use his new position to raise awareness and curb the illegitimate proliferation of conventional weapons in the global community. His assumed responsibilities include creating programs that help build the requisite local and regional conditions for stability, prosperity and peace. *The Journal of ERW and Mine Action* had the opportunity to interview Brown on how his past experience will influence his new role and vision for PM/WRA.

JOURNAL: How has your past experience, for instance your extensive experience with the United States Air Force, military experience in the field and position as Chief of Special Operations with the Office of the Coordinator for Counterterrorism, prepared you for your new role as director of PM/WRA?

BROWN: My initial assignment at the Department of State [DOS] was from 2000–2003 in the Office of Counterterrorism [and] was defined by a number of terrorist events. I served on the Foreign Emergency Support Team and was part of the crisis response on the interagency team to assist in the recovery of the USS Cole after the terrorist attack. I also coordinated the diplomatic concurrence to numerous special operations deployments and exercises in the lead up to conflicts in Afghanistan and Iraq. My initial experience in the Office of Counterterrorism helped me learn how the DOS worked. I learned a whole new vocabulary with many acronyms. I recognized how culturally different State was from the Department of Defense [DoD] and found a group of professionals that were focused on accomplishing the mission through diplomacy.



Col. (Ret.) Stanley L. Brown.
Photo courtesy of the U.S. Department of State.

JOURNAL: You have worked as a liaison between DOS and DoD for a number of years. How has the interagency climate changed over the years? How does this cooperation facilitate the work of both?

BROWN: When I retired from the Air Force and was appointed director for PM/WRA, I had eight years at DOS. I worked three years in the Office of the Coordinator for Counterterrorism, two years as the Deputy of United States Special Operations Command's Special Operations Support Team as a liaison to the Political-Military (PM) Affairs Bureau and as the director of International Security Operations in the PM Bureau. Since my initial assignment in 2000, I have seen both departments grow closer together.

FACES OF MINE ACTION



The shared experience of DOS and DoD personnel deployed to Afghanistan and Iraq has increased our mutual understanding of the missions of the two departments. While the culture of the organizations may differ, we have much more in common than there are differences. Additionally, different perspectives can help us understand each other while we are often working in overlapping operational spaces around the world.

JOURNAL: What initially attracted you to work at PM/WRA?

BROWN: I liked the work that the State Department accomplishes around the world, but for most of my career in the Air Force, including my previous assignments at DOS, I was focused on operational issues. PM/WRA has a very important humanitarian and national security mission where we are able to see the immediate impact of our conventional weapons-destruction programs. Whether it is humanitarian mine action that encompasses demining, survivor assistance and mine risk education, or curbing the proliferation of at-risk small arms and light weapons (SA/LW) including man-portable air-defense systems (MANPADS), PM/WRA's mission helps civilian communities rebuild after conflict. Additionally, PM/WRA's staff has a great reputation, and it is evident that the mission has a positive impact on the overall team.

JOURNAL: Based on your experiences, are there any issues that PM/WRA addresses that seem particularly urgent to you? Have you faced challenges from the illicit proliferation of conventional weapons or seen their repercussions firsthand?

BROWN: Humanitarian mine action is still extremely important because of the impact that it has on civilian populations. However, increasingly the illicit proliferation of SA/LW, including MANPADS, is having a significant impact in regional conflicts. As a pilot in the Air Force flying large cargo aircraft in conflict areas, we consistently employed tactics to reduce the threat posed by SA/LW including MANPADS. I trained for and saw this threat firsthand as I flew combat missions in Afghanistan.

JOURNAL: What do you believe will be your biggest challenge as the new director of PM/WRA?

BROWN: While PM/WRA funding has remained relatively stable over time, there has been a decrease in funding for conventional weapons-destruction programs overall. We must continue to be good stewards of taxpayer dollars and ensure that the programs we support will have the largest impact on society and support our national security priorities. Close coordination with our U.S. interagency partners, such as DoD and USAID, our implementing partners, donor

countries, affected states, and international and regional organizations such as the U.N. and Organization of American States is an essential part of this approach. This enables us to facilitate the most effective and efficient delivery of assistance with a flexible approach that is responsive to rapidly changing situations.

JOURNAL: What do you believe are some of the most significant challenges PM/WRA currently faces? In what regions of the world do these challenges occur?

BROWN: One of the biggest challenges that PM/WRA is facing is the proliferation of SA/LW in Africa following the conflict in Libya where much of the weapons have fallen out of government control. Our focus is to join with partners in the region to help stem the flow of these weapons and keep them out of the hands of those who would harm civilians or threaten our national security.

JOURNAL: How important is empowering local populations to handle their own mine action, explosive remnants of war (ERW) and SA/LW issues? How does PM/WRA do this?

BROWN: It is extremely important for local populations to take responsibility for their own mine action, ERW and SA/LW issues. PM/WRA facilitates this participation by encouraging countries to develop the expertise to manage these issues and share the cost of humanitarian mine action activities. Additionally, PM/WRA, through implementing partners, encourages programs that are self-sustaining or can be leveraged to help in other areas. For instance, PM/WRA used Bosnian mine-detection dog-training teams to train dogs and handlers in Northern Iraq.

JOURNAL: What parts of your work as director are you especially looking forward to? What have you enjoyed the most so far?

BROWN: President Obama made a strategic decision at the beginning of this Administration to focus on the Asia-Pacific region by rebalancing our engagement and resources toward this vital region, and I am looking forward to leading our efforts to assist in the cleanup of ERW and unexploded ordnance that dates back to World War II and Vietnam. [Moreover,] I have enjoyed working with a great team of enthusiastic professionals, including our implementing partners, who are committed to conventional weapons-destruction programs around the world.

JOURNAL: Would you tell us a little bit about yourself and how you chose to pursue a leadership role at DOS?

BROWN: I am originally from Lillington, North Carolina [N.C.]. Over my career, I have had four assignments to the Washington, D.C., area and have immensely enjoyed each one ... traffic is another discussion. Washington, D.C., has

something for everyone. When I was in high school, living near Pope Air Force Base, N.C., and Fort Bragg, N.C., I was interested in serving in the military. I joined Army Junior Reserve Officer Training Corps in high school and joined the Air Force Reserve Officer Training Corps in college. It was in college that I committed to joining the Air Force and going to pilot training.

My first assignment to the State Department was a total surprise with about 90 days' notice to report. After my initial tour at DOS, any subsequent discussions about career assignments in the D.C. area resulted in my return to State in different capacities. I would not change a thing. The professionals that I have met and my experience at the State Department have been great, and I feel privileged that, following my service in the Air Force, I have been able to continue my service to the country with an-

other great team in PM/WRA with an exciting and important mission.

JOURNAL: What do you hope to accomplish through your new role as director of PM/WRA?

BROWN: I want to continue to raise awareness for conventional weapons-destruction efforts including humanitarian mine action. I want to continue efforts to keep conventional weapons-destruction programs funded, because they have proven to be a modest investment that is saving lives and fostering stability.

The program helps countries recover from conflict and create safe, secure environments to rebuild infrastructure, return displaced citizens to their homes and livelihoods, assist survivors to integrate into society, and establish conditions conducive to stability, nonviolence and democracy. I am honored to work with such a program. ©



Alexandra Berkowitz joined CISR in June 2013 as an editorial assistant. She is a junior at James Madison University majoring in international affairs with minors in Spanish and creative writing. She plans to continue her education by attending graduate school to study international peace and conflict resolution.

Alexandra Berkowitz
 Editorial Assistant
 Center for International
 Stabilization and Recovery
 James Madison University
 Harrisonburg, VA 22807 / USA
 Email: cisr@jmu.edu

News Brief

U.S. and Vietnam Sign Memorandum of Understanding

On 16 December 2013, U.S. Ambassador to Vietnam David Shear signed a memorandum of understanding (MOU) on explosive remnants of war (ERW) cooperation.¹ Bul Hong Linh, the deputy minister of the Ministry of Labour - Invalids and Social Affairs (MOLISA), signed the MOU for Vietnam. The memorandum is important, said Linh, as it broadly outlines areas for cooperation between the two countries to confront ERW in Vietnam.²

Following the signing of this MOU, the government of Vietnam announced the establishment of the Vietnam National Mine Action Centre on 14 March 2014 during the Development Partnership Conference on Mine Action. In attendance at the conference, Deputy Assistant Secretary Samuel Perez noted that the MOU on ERW cooperation illustrates the U.S. commitment to helping Vietnam address war legacy issues.

According to the *Landmine and Cluster Munition Monitor*, 104,973 mine/ERW casualties (38,940 killed/66,033 injured) occurred

in Vietnam through 2012. Reported casualties in 2012 (18 killed/53 injured/two unknown) showed a significant increase over previous years, but the reason for the increase is unknown.³

Vietnam's UXO contamination stems from three decades of conflict, beginning with the communist uprising against French Colonial power in the 1940s and ending with the 1975 fall of Saigon. Despite years of clearance efforts, some areas in Vietnam remain highly contaminated by UXO and landmines, especially the central region and the Vietnam-Laos border.⁴

A Vietnamese Ministry of Defense 2009 survey states that UXO contaminates approximately 35 percent of the country's central region.⁵ In a 2002 survey, MOLISA reported that UXO contaminates 6.6 million hectares (16.3 million acres) of Vietnamese land, not including maritime areas. MOLISA also noted that only 20 percent of UXO were found and defused.¹ ©

~ Chloe Cunningham, CISR staff
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Outcome Monitoring in Humanitarian Mine Action

Humanitarian mine action programs are attempting to develop better ways to monitor and document the socioeconomic results of their programs. Lessons learned from the development and use of Danish Demining Group’s Impact Monitoring System provide examples of how to build or improve current outcome- and impact-monitoring systems.

by Mikkel Nedergaard [Danish Demining Group]

More than a decade ago, increased attention to socioeconomic impact was seen as a quiet revolution in humanitarian mine action (HMA).¹ Since then, the norm within many HMA nongovernmental organizations (NGO) has gradually included measuring outcomes and impact as part of internal program monitoring and evaluation. Today the question of what difference mine action activities have made to the local population is posed as commonly as questions regarding the number of square meters cleared or landmines removed.

There is a strong tradition of operational data collection within mine action. However, recently it has been debated whether HMA NGOs have the necessary capacity and skills to measure the socioeconomic effects of mine action.² This debate often overlooks the fact that keeping outcome- and impact-monitoring systems simple is the best way to ensure that the collected data remains useful and relevant for operations. Sophisticated monitoring and evaluation systems are not necessarily what HMA actors need to gain an improved understanding of their programs’ socioeconomic outcomes and impact.

Building an Outcome and Impact-Monitoring System

In 2009 Danish Demining Group (DDG) introduced an internal monitoring system that systematically measures the outcomes and impact of its mine action operations in order to improve understanding of their effectiveness.³ DDG has a dedicated monitoring and evaluation adviser at its Copenhagen, Denmark, headquarters and impact-monitoring focal points in each country program. Before and after project implementation, data is collected through different methods, such as focus-group discussions and questionnaire surveys conduct-

Output monitoring:
Day-to-day monitoring of activities

- Key question: Are we doing what we said we would do?
- Examples of output reference indicators:
 - Number of square meters land released
 - Number of items removed
 - Number of people sensitized with risk education
 - Number of people trained

Outcome and impact monitoring:
Before and after project implementation

- Key question: Are we making a difference?
- Examples of outcome and impact reference indicators:
 - Changes in land use of released land
 - Amount of released land brought into productive use, e.g., housing, agriculture, grazing
 - Number of men and women benefiting from released land
 - Number of people who worry about accidents with mines or remnants of war (feeling of safety)
 - Number of accidents reported

Figure 1. Examples of DDG reference indicators for output and outcome.
Figure courtesy of DDG.

ed with beneficiaries. DDG’s system is built around a set of reference indicators (as shown in Figure 1).

The organization has been on a steep learning curve. In 2009, DDG began using a standardized approach, in which all DDG country programs used similar methods and tools. Today, DDG has a flexible approach, taking into account specific country-program needs. The following sections highlight lessons learned.

Purpose of Monitoring Outcome and Impact

Before developing technical guidelines and choosing data handling systems, the purpose of the outcome monitoring system should be clearly defined in order to avoid data collection becoming a goal in itself. More often, outcome-monitoring systems are built to enable stakeholder accountability or organizational learning.

At DDG, the impact-monitoring system is predominately a tool for improving organizational learning and informs

strategic decision-making on operation effectiveness. While stakeholder accountability toward both local communities and donors is important, it has not been the main driver in the development of the system. The data from impact and outcome monitoring is used for donor reporting but often falls outside their formal reporting requirements. Since impact monitoring is conducted six months after operations have ended, donor reporting deadlines often pass before it is possible to collect and utilize data. In addition, few donors have formal requirements about reporting on outcome data beyond what is included in externally commissioned evaluations. At DDG, accountability toward the local communities is organized around the humanitarian accountability partnership and therefore falls under a reporting framework different from the impact-monitoring system.⁴

Another reason for having a clearly defined purpose for the monitoring system is to ensure that data collection efforts are not duplicated within the organization. Evaluation of current data collection should be a part of the process to define the monitoring system's purpose. As a sector, mine action has a strong culture of collecting operational data, and national authorities and NGOs spend many resources to collect output data. With an overview of systems and processes in place, the new system will more easily integrate into existing structures.

Use of Collected Data

Of equal importance to knowing the system's purpose is having a clearly articulated procedure for how the system's information feeds into the organization's decision-making processes. At DDG, the impact- and outcome-monitoring data go into the yearly planning cycle as shown in Figure 2. Findings from the outcome and impact data then feed into strategic decision-making processes at annual management meetings.

In the field, operational staff are likely to have different needs for the system than program-management staff. On one hand, the system needs to produce data relevant to daily operations and sensitive to on-site situations. On the other hand,

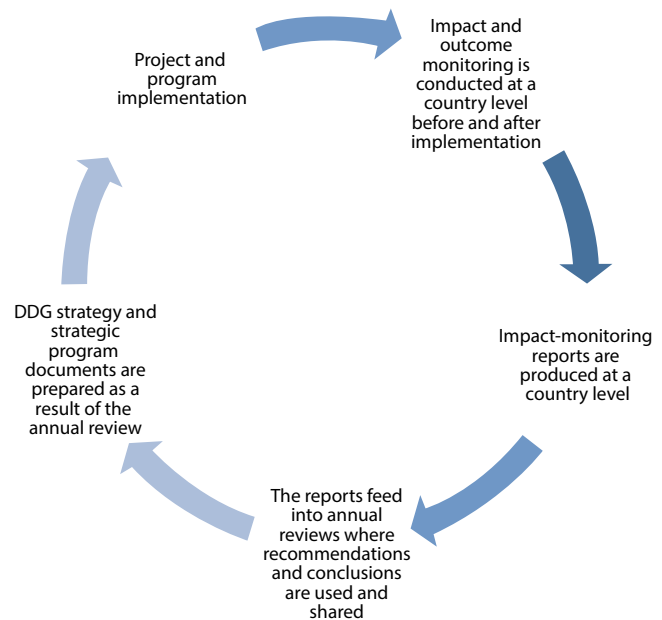


Figure 2. Feedback loop: information from impact- and outcome measurement feeds into the strategic decision-making process at DDG.

Figure courtesy of DDG.

the system also needs to produce data that can be aggregated at a global level. Hence, the system has to have a degree of flexibility, which can be difficult to manage. Deciding which procedures and practices are mandatory and which are optional is essential, e.g., data collection methods, data storage and handling practices, etc., becomes critical.⁵

Since 2009 DDG has moved from a generic to a toolbox approach. Each country program can choose the approach that best fits its specific resources and needs within the boundaries of an overall framework set out by an impact-monitoring manual and key reference outcome and impact indicators.

Training and System Maintenance

However simple an outcome-monitoring system is, it is likely high maintenance. At DDG, training staff in data collection and analysis is not a one-off activity but needs revisiting on an annual basis. For instance, facilitation of focus-group

Somaliland: Funnel Approach to Data Collection

When collecting data before an intervention, knowing what information will be significant over time can be a challenge. Initially, DDG country programs used standardized questionnaires to facilitate cross-country comparisons. In Somaliland, where DDG has operated since 1999, this created multiple challenges. Since it covered a wide range of topics, the questionnaire unavoidably provided information irrelevant to the country program. Moreover, the questionnaire was lengthy and time-consuming, which led to the local community's unwillingness to participate, and the data collectors became unenthusiastic. In response, DDG shortened the questionnaire to a more manageable length by excluding questions that did not generate relevant information for the specific program. Similarly, more emphasis was placed on training data collectors to use various participatory data collection methods that improve the expediency at which the data is collected without compromising the quality of the data.



Development takes time in places severely damaged by war such as in Sirte, Libya (2012).
Photo courtesy of Giovanni Diffidenti.

discussions—a commonly used data-collection method within many NGOs—is a hugely challenging task for unskilled data collectors. Recently Robert Chambers, a noted development researcher and scholar, stated that the lack of skilled focus-group facilitators is one of the biggest challenges to the quality of data collection in the field.⁶ This might be one reason why some organizations rely solely on questionnaire surveys and quantitative data, which often leads to a lot of information on what changes took place and very little information on why these changes occurred.

Additionally, HMA organizations must determine how much data is needed. Most organizations have a tendency to collect too much data and overestimate the amount of data they can process. DDG's experience indicates that it is better to start with a few easily measurable indicators when developing a system.

Debating the Local Effects of Mine Action

An important issue to consider is the level of socioeconomic effect that one can realistically expect from HMA programs. The effects of mine action are in many cases obvious, such as reducing accidents and the reduction of fear among

populations living with the dangers of landmines and unexploded ordnance. However, the broader socioeconomic effects or links to development are often much less assessable. Therefore, a bit of realism is desirable when evaluating the socioeconomic effects of mine action. In many areas where DDG operates, populations live in chronic poverty. While most mine action operations leave communities safer and with opportunities to become more productive, they will not ameliorate poverty as it can take decades for socioeconomic development to occur. Rather, HMA facilitates development by enabling local communities to be safe and control their environment instead of being dominated by hazardous circumstances.

When measuring mine action's impact six months after clearance activities end, not all effects will have materialized. Sometimes, local communities need to wait for the right time of year to plant or to find resources to productively use more land. At DDG, the focus of the outcome- and impact-monitoring system is on the short-term effects of land release—such as land-use changes and the amount of land actively used—not on the long-term effects in terms of increased food production and consumption. Therefore, the system more often measures outcomes than impacts of operations.



Cluster munitions were removed from this family's land in Basra, Iraq, enabling them to expand their land under cultivation. Photo courtesy of the author.

Recommendations for Outcome Measurement Systems in Mine Action

- What is the purpose of the data collection system?
- How will the data be used and by whom?
- How will the system be maintained?
- Be realistic about the local socioeconomic effects of mine action

Figure 3. Recommendations for outcome-measurement systems in mine action. Figure courtesy of DDG.

Moving Forward with Outcome Monitoring in Mine Action

For DDG, improving the outcome- and impact-monitoring system is important. This challenge is best tackled through sharing knowledge and experiences with other HMA actors. A range of experience on outcome measurement is emerging within HMA. Recently, steps have been taken to engage in more cooperation on data collection. In June 2013, DDG and the United Nations Mine Action Service facilitated a meeting of mine action NGOs in Copenhagen

with the purpose of sharing experiences implementing outcome monitoring.⁷ Sharing experiences is necessary since, unlike other humanitarian sectors, no common guidelines exist on best practices for defining and measuring HMA's outcomes and impact. Hopefully, future initiatives can address this void. Increased sharing of outcome-measurement practices between HMA actors will help build more evidence of the socioeconomic effects of mine action activities.⁸ ©

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Mikkel Nedergaard is the monitoring and evaluation advisor at Danish Demining Group, which is part of the Danish Refugee Council. He holds a master's degree in human geography from the University of Copenhagen (Denmark). Nedergaard has worked in project management, assessment and evaluation for over a decade.

Mikkel Nedergaard
Monitoring and Evaluation Advisor
Danish Demining Group
Danish Refugee Council
Borgergade 10
Copenhagen / Denmark
Tel: +45 3373 5119
Email: mikkel.nedergaard@drc.dk
Website: danishdemininggroup.dk

Amendments to the IMAS Land Release Series

The International Mine Action Standards (IMAS) review board formally endorsed amendments to the Land Release IMAS in April 2013 that clarify and standardize the language and practices in the series.

by Helen Gray [GICHD]

Land release is the effective and efficient application of survey and clearance to remove the threat of landmine and explosive remnants of war (ERW) contamination. Within and between countries, this contamination can vary widely based on a range of factors. The type and timing of conflict, number of warring parties and physical terrain, among other factors, determine the nature of contamination and the necessary response.

By definition, the land release process involves non-technical survey (NTS), technical survey (TS) and clearance activities. A land release pyramid, which emphasizes the value of survey activities, illustrates the land release process (Figure 1). In addition to allocating sufficient resources for high-quality survey, an efficient process relies on accurate information, risk management and the ability to maintain a clear record of past achievements and outstanding tasks.

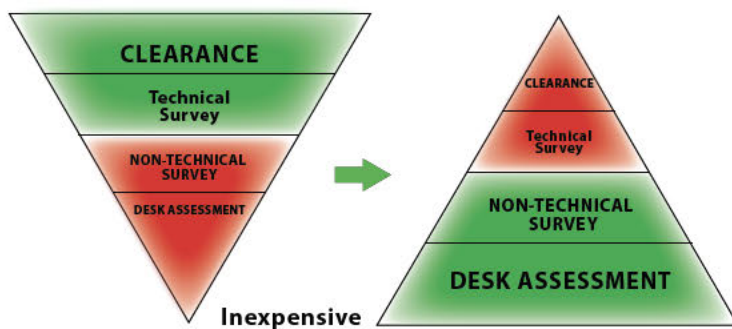


Figure 1. Evolution of the land release pyramid.
All graphics courtesy of the author/GICHD.

The land release pyramid illustrates the transformation from the traditional approach of clearance. Many governments employ clearance by default to eradicate suspected explosive hazards. Modern land release methodology provides a more efficient approach.

IMAS

The Land Release International Mine Actions Standards (IMAS) were reviewed and updated since their original introduction in 2009.¹ In April 2013 the IMAS Review Board formally endorsed the amendments. Arguably the most important IMAS, changes within the Land Release IMAS are prompting further changes across the rest of the IMAS series as well as to national mine action standards (NMAS) and standard operating procedures (SOP).

In addition to changes within the documents, the Land Release IMAS were reorganized within the IMAS series structure. The now broader Land Release IMAS were promoted to the operational management level and provide a more consistent approach to distinguishing between standards relating to the broader management of activity and to those addressing requirements of specific activities. This series now examines the interrelationship between survey and clearance more clearly, alleviating some of the confusion surrounding the use of the term *land release*. The Mine/ERW Survey Series and the Mine/ERW Clearance Series cover the specifics of NTS and TS.

Principal Changes

The main purpose of the amendments is to provide greater clarity and consistency. The standards adopted language more compatible with the International Organization for Standardization (ISO). While setting out principles applicable to global landmine and ERW settings, these amendments allow for further elaboration in NMAS, Technical Notes and SOPs. National authorities are responsible for describing how the land release process should be applied within their country context.

The spirit of IMAS is to promote operational efficiency by allocating expensive resources to legitimate areas of contamination and to improve data collection and reporting through

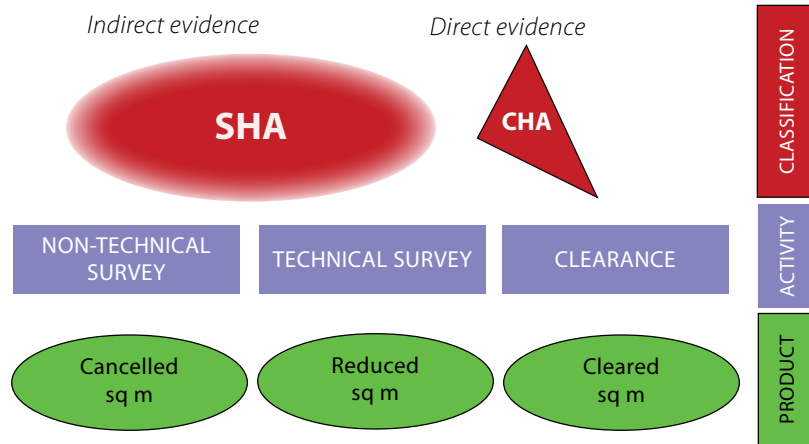


Figure 2. The land release process.

greater standardization and transparency. Although the terminology was largely maintained, the definitions were clarified. Figure 2 summarizes the components of the land release process.

A two-tier system of land classification has been promoted: Hazardous areas are either suspected hazardous areas (SHA) or confirmed hazardous areas (CHA) according to the availability and quality of evidence. The classification of defined hazardous areas was removed, as it was not globally applicable and could only be identified retrospectively in many cases.

SHAs should be classified based on indirect evidence of contamination, whereas CHAs should rely on direct evidence. Furthermore, this evidence-based approach discourages the creation of SHAs unless credible information can justify such a decision. This does not exclude countries or organizations that use more complex land classification schemes, as long as the schemes can be simplified to the industry standard.

NTS, TS and clearance are the activities used to identify mine and ERW contamination and return safe land to productive use. When applied to a hazardous area, the products of these activities are measured in square meters and labeled cancelled, reduced or cleared

land. In locations where no hazardous areas are recorded and NTS confirms that no suspicion exists, the result of the NTS should be recorded to confirm there is no current contamination. Yet, this does not result in cancelled square meters, because square meters can only be cancelled from already existing mapped SHA/CHAs.

The land release process prevents the full clearance of areas when the less expensive, more rapid NTS or TS methods could be employed to cancel or reduce land contamination. This puts greater

emphasis on finding the best sources of information and identifying evidence to improve operational decisions and efficiency. In particular, this process highlights the importance of high quality and continuous NTS activities, which better define where TS or clearance should start and how best to support decision-making when operations are underway. Where possible, a dynamic approach should be taken in which survey and clearance plans can be changed and updated as better information becomes available (Figure 3).

NTS should be conducted by trained staff who can gather and critically analyze information from a broad range of stakeholders in affected communities and map hazardous areas as accurately as possible. As a guide, these maps can help plan clearance activities; however, there should be leeway to edit, update and redraw boundaries of hazardous areas when more credible information becomes available. Work should be planned based on up-to-date information and not solely on existing maps. Where appropriate, TS can

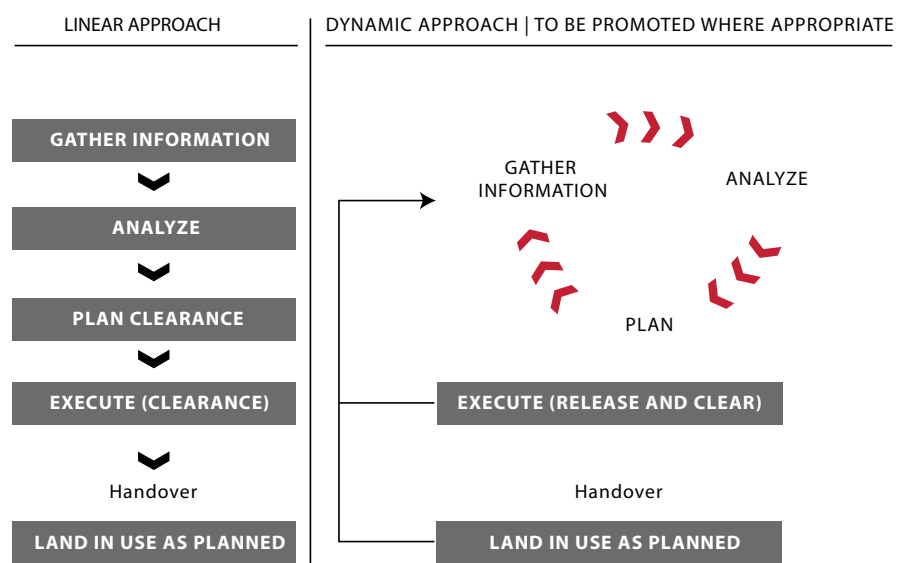


Figure 3. Linear versus dynamic approach to information gathering and operational adjustment.

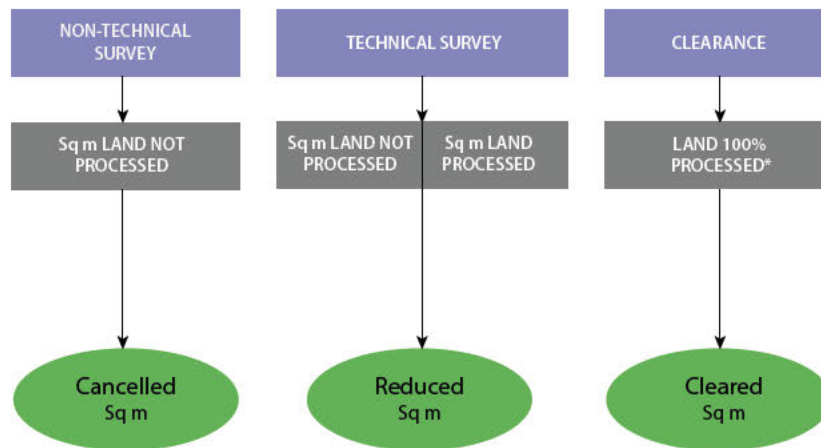


Figure 4. Minimum reporting requirements reflecting the effort made to release land. *Land processed by an accredited clearance asset.

facilitate the process of gathering better information and limit instances where hazardous areas are unnecessarily exposed to full clearance.

Information Management

Since their publication in 2009, the Land Release IMAS have had a lack of reporting clarity. The tendency to group activities together and report them as land release fails to reflect the effort and genuine benefit of activities on the ground, such as NTS, TS and clearance. Instead, the different survey and clearance components need reporting and disaggregation in databases to better reflect efforts and to enhance clarity when comparing work undertaken. To make this possible and improve activity analyses, quality hard data needs to be collected throughout the survey and clearance process. Capturing activities undertaken, the location and, if possible, degradation level of contamination is vital. This does not necessarily require the application of high-tech solutions but rather the proper use of basic mapping tools.

Data collection should also reflect reporting requirements: national reporting, operational analysis, donor reporting and reporting on treaty obli-

gations. Where appropriate, data should be disaggregated by age and sex. Unnecessary data collection should be avoided. If data collection cannot be explained, it should be reconsidered.

The drive for improved data collection and clarity also has implications when considering data quality in national databases. Poor quality data persists. A pragmatic approach should be taken to clean up national databases, so that false data is removed and is not used as a benchmark for planning or measuring progress.

Following TS, statistical reporting of the reduced area should reflect the reality of the situation on the ground. Where TS is applied to a percentage of the area, the statistics should be separable and reflect the area processed by a TS asset instead of the area that was not processed but was reduced after technical intervention. Figure 4 illustrates the minimum standard for data collection.

The updated IMAS therefore promote improved data analysis for more informed decision-making, allowing operators to learn from experience.

Conclusion

In a sector with decreasing funds, more must be done with less. Learning

from past experiences helps improve efficiency while meeting beneficiary needs. The land release process enables pragmatic decision-making to better target clearance assets and minimize residual risk. ©

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Helen Gray worked for The HALO Trust between 2004 and 2012, managing demining operations and surveys in Angola, Colombia and Mozambique. She joined GICHD in 2013 and advises on land release and operational efficiency. She has a bachelor's degree in natural sciences from Durham University (U.K.).

Helen Gray
Advisor, Land Release and
Operational Efficiency
Geneva International Centre
for Humanitarian Demining
Chemin Eugène-Rigot 2C
P.O. Box 13001211
Geneva 1 / Switzerland
Tel: +41 (0)22 730 93 40
Fax: +41 (0)22 730 93 62
Email: h.gray@gichd.org
Skype: gichd.h.gray
Website: <http://gichd.org>

Effects of Mixed Teams on Land Release

The Gender and Mine Action Programme (GMAP) investigated the impact of mixed gender teams on land release. Based on the opinion of the respondents, as well as gender baseline assessments conducted by GMAP, the organization found that in most cases mixed teams in the land release process are primarily associated with the employment of women and its effect on the teams. Some mine action managers indicated that mixed teams actually enable better access to information while only a few respondents indicated that more accurate and inclusive information will allow mine action organizations to prioritize tasks where the impact is highest. This demonstrates that despite arguments in favor of mixed teams, their importance is still not fully understood in the mine action sector.

by Arianna Calza Bini, Nyske Janssen and Abigail Jones [Gender and Mine Action Programme]

Despite increasing global recognition that mixed gender teams can benefit land release, sufficient documentation does not exist to support this. In 2013 the Gender and Mine Action Programme (GMAP) started to map first-hand experiences by sending a short questionnaire to current and former operations, program and community liaison managers working in the field of mine action. The 10 respondents have worked for different international nongovernmental organizations in North and Central Africa, the Middle East and Southeast Asia. The respondents were invited to share their personal experiences from 2003–2013 as well as opinions on the perceived impact of mixed gender and male teams on non-technical survey, clearance and handover.

In addition, findings were analyzed from seven gender baseline assessments involving more than 400 people. For these assessments, GMAP conducted individual interviews, focus group discussions, staff surveys and direct observation of local staff and expatriates in six different countries during 2012–2013. GMAP observed that impact was most frequently interpreted as effect; hence, the results of this analysis are presented as effects on the individual, effects on the team and effects on younger and older members of impacted communities, both male and female.^{1,2}



HALO non-technical survey training in March 2013 in El Retiro, Colombia.

Photo courtesy of Grant Salisbury.

Mixed Teams in Land Release

Land release in mine action focuses on operational efficiency, the quality of the process and its results. Relative to a gender perspective, the three key steps are

- Hire the most qualified teams for the job
- Obtain information on contamination from affected women, girls, boys and men
- Ensure the entire community is informed that released land is safe to use³

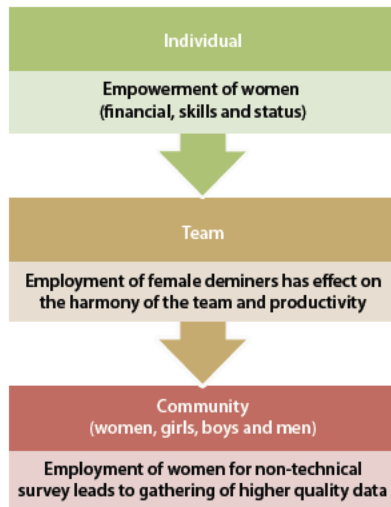


Figure 1. Perceived positive effects of mixed teams at the individual, team and community levels.
Figure courtesy of the authors.

Due to cultural restrictions, access to information is limited in many impacted countries. As a result, teams should be composed of mixed genders. The benefits of mixed gender teams are threefold:

- Equal access to employment opportunities empowers men and women.
- The collection of more complete comprehensive data for mapping hazard areas is better facilitated as a result of increased access to women and children in affected communities. Because of the context-sensitive approach, teams also have more access to men who are not community leaders.
- Including all landowners and possible end users in the handover process better ensures that released land is used productively.

Moreover, frameworks of international guidance for gender mainstreaming in land release exist. The Cartagena Action Plan of the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBBC), the Vientiane Action Plan of the *Convention on Cluster Munitions* and the International Mine Action Standards on land release each reference the need for an integrated gender dimension within land release activities.^{4,5,6}

Effects on the Individual

Earlier GMAP research illustrates that female employment has a positive impact at the individual level.⁷ Employing women in management positions demonstrates to the community that women are physically and psychologically capable of fulfilling high-level positions with equal productivity.

Individually, income often empowers women, and other females within the community see them as positive role models. Relatedly, a woman's status in her family and community rises. However, what happens to the women after mine action activities conclude is not documented. Based on experience with female deminers, one respondent said, "If women did not hold a mid-management position, they most likely fall back into the roles they held before their employment."

The gender baseline assessments and staff survey findings supported arguments for mixed employment in mine action. Respondents stated that financial needs, helping the community and the opportunity to learn new skills were frequently reasons for both men and women to work in mine action. Questionnaire responses from managers suggested that most women become deminers due to financial motivations. The effect of employment on women's lives and their role in the community was seldom referenced, and only one respondent mentioned that employment in mine action could empower women.

Effects on the Team

When asked about their experience regarding mixed-team employment, the surveyed local managers and field staff typically highlighted positive effects on their projects. These testimonies noted

- Men become more competitive due to stigma associated with performing worse than women.
- Women bring more harmony to teams.
- Women increase effectiveness but not efficiency.

A frequent survey answer from expat operations managers (typically from developed countries) with mixed team experience seemed less positive, because in their opinion "its success is country specific" and "should never be forced when it is not in accordance with cultural norms," and therefore the focus should be on "only employing the best candidate."

Effects in Impacted Communities

In examining the effects of mixed teams during non-technical surveys, survey responses suggested that teams employing women had better access to women and children in affected communities. Whether this better access leads to the collection of more complete and accurate information about the locations of potential explosive hazards or other risk factors is undocumented. Although not every participant demonstrated improved effectiveness from mixed teams, certainly better access to information allows them to prioritize the tasks where the impact for all groups is highest. In focus group discussions, participants agreed on the significance of having women conduct surveys and fulfill community liaison

activities in order to access a wider range of stakeholders in a community and collect information on contamination and priorities for clearance from women, girls, boys and men.

Regarding the perceived effect of mixed teams during the handover of cleared land to younger and older men and women, a range of answers included

- The handover is worse because “people do not trust women enough” and will doubt the safety of the land.
- The effect is identical to male-only teams.
- The handover is better “because women reinforce confidence in women in the use of cleared land.”

The unique circumstances the participants in the survey faced likely influenced these varied responses. Negative experiences commonly came from those working in North African countries, whereas positive experiences often came from Central and South African countries. Other regions reported no effect of mixed teams.

Areas of Future Research

Respondents associate mixed teams in the land release process primarily with the employment of women and its effect on the team. Many practitioners seem less aware of the broader positive benefits on males and females of all ages, i.e., better access to information from women, girls,

boys and men in affected communities which allows mine action organizations to prioritize tasks where the impact for all groups is highest.

The findings also point to a number of areas that require further research in order to better understand the long-term developmental impact of mixed teams in land release settings:

- What is the impact of employment in mine action on men’s and women’s lives and gender equality?
- What happens to the status and position of men and women after their employment in mine action ends?
- Do mixed teams have varying effects based upon the type of land released (common land, private fields, roads, etc.), and how do the different types impact the livelihoods of all members of affected communities?
- What is the impact on the survey quality? Does it lead to better planning, more efficient operations, lower costs and more beneficiaries?
- How important of a factor is culture for the use of mixed teams in land release?

GMAP is interested in receiving details about the experience and opinions of any interested party on the effect of mixed (male/female) non-technical survey teams on mine/explosive remnants of war affected communities. To participate in the study, contact info@gmap.ch. ©

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Arianna Calza Bini is the director of the Gender and Mine Action Programme (GMAP). She has worked as program manager and gender adviser at the European Union Delegation to Brazil and as gender and poverty officer for the United Nations Development Programme in El Salvador. She holds a Master of Philosophy in development studies from the Institute of Development Studies (U.K.) and an advanced degree in economics from the University of Rome (Italy).

Arianna Calza Bini
Programme Director
Gender and Mine Action Programme
P.O. Box 1300 | 1211
Geneva 1 / Switzerland
Tel: +41 (0)22 730 9335
Fax: +41 22 730 9362
Email: a.calza-bini@gmap.ch
Website: <http://gmap.ch>



Nyske Janssen is programme assistant at the Gender and Mine Action Programme in Geneva. She previously worked with the International Labour Organization on the feminization of the informal sector and with the Dutch Ministry of Foreign Affairs on the Millennium Development Goal 3 Fund. Janssen holds a master’s degree in gender studies from the University of Sussex (U.K.) and a bachelor’s degree in political science from the University of Amsterdam (Netherlands).

Nyske Janssen
Programme Assistant
Gender and Mine Action Programme
Email: gmap02@gmap.ch



Abigail Jones is the programme manager at the Gender and Mine Action Programme in Geneva. She previously worked as a community liaison manager with MAG (Mines Advisory Group) in the Democratic Republic of the Congo and has also worked in Kenya, Pakistan and Sierra Leone. Her academic background includes a Master of Science in international development from the School of Oriental and African Studies, University of London (U.K.) and a Bachelor of Arts (Honors) in international relations from the University of Birmingham (U.K.).

Abigail Jones
Programme Manager
Gender and Mine Action Programme
Tel: + 41 (0)22 730 9336
Email: a.jones@gmap.ch

Scalable Technical Survey for Improved Land-release Rates

Norwegian People's Aid (NPA) tailors technical survey (TS) to allow for more efficient use of mine action assets and improved land-release rates. Many organizations consider TS an isolated activity and fail to streamline and effectively implement TS as a tool to reduce unnecessary, time-consuming and costly deployment of mine action resources.

by Håvard Bach [Norwegian People's Aid]

Land release refers to the decision-making process behind identifying, defining and removing all presence or suspicion of mines or explosive remnants of war (ERW) from an area. The basic approach to land release is to apply **all reasonable effort** to identify and subsequently release all confirmed hazardous areas (CHA) by using an evidence-based survey approach comprising non-technical survey (NTS), technical survey (TS) and clearance. CHAs are released when it can be confidently concluded that no mines are present in the area or that all mines and cluster munition remnants (CMR) were cleared (removed or destroyed) from the area. **All reasonable effort** describes a minimum level of effort acceptable for identifying and documenting contaminated areas or for removing the presence or suspicion of landmines and ERW. It applies to the required effort and the quality of survey and clearance.

NPA's land-release methodology is adaptable to accommodate unique situations in any given country with universally applicable, generic principles. When releasing land, NPA collects and analyzes evidence of mines/ERW, including CMR, and employs a process to identify degrees of confidence in mined or mine-free areas. This scale of confidence provides a basis for determining further survey-related action and a mechanism that can justify land release once high confidence in a mine-free area is attained. Two interlinked processes are fundamental for the effective implementation of clearance obligations under the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMB) and the *Convention on Cluster Munitions* (CCM): Every effort must be taken to identify the problem, and resolving the problem and releasing contaminated land requires efficient processes.

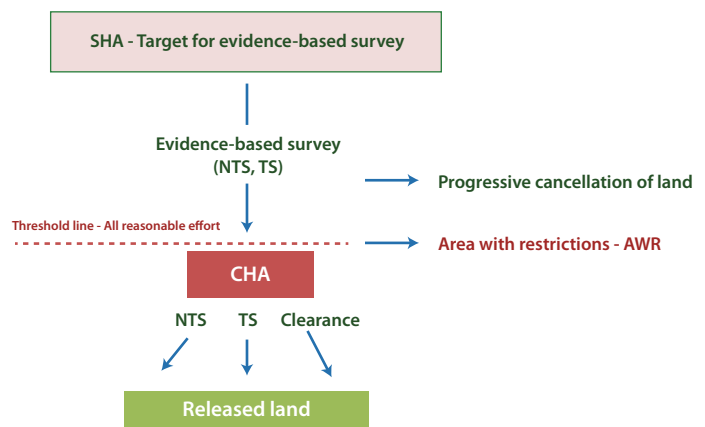


Figure 1. Principal layout of the survey and land release process. It is applicable to countries that are States Parties with clearance obligations under the APMB and CCM, as well as all countries with contamination.

All figures courtesy of the author.

Extent of Contamination

Understanding how various components of survey and land release interlink requires a clear and explicit layout of the wider survey and land-release process. Implementing the provisions of the conventions requires a major survey effort before identifying and recording contaminated areas. States Parties often neglect this requirement and record contamination too hastily, which makes the size of contamination appear more extensive than it is in reality and leads to the disproportionate use of TS and clearance resources.

NPA's land-release concepts emphasize evidence-based survey and accurate recording of contamination before attempting to carry out clearance. Emphasis must be on confirmed evidence of mines/CMR as opposed to liberal recordings of large areas with unspecified residual risk, which increase in large unpopulated areas where information about contamination

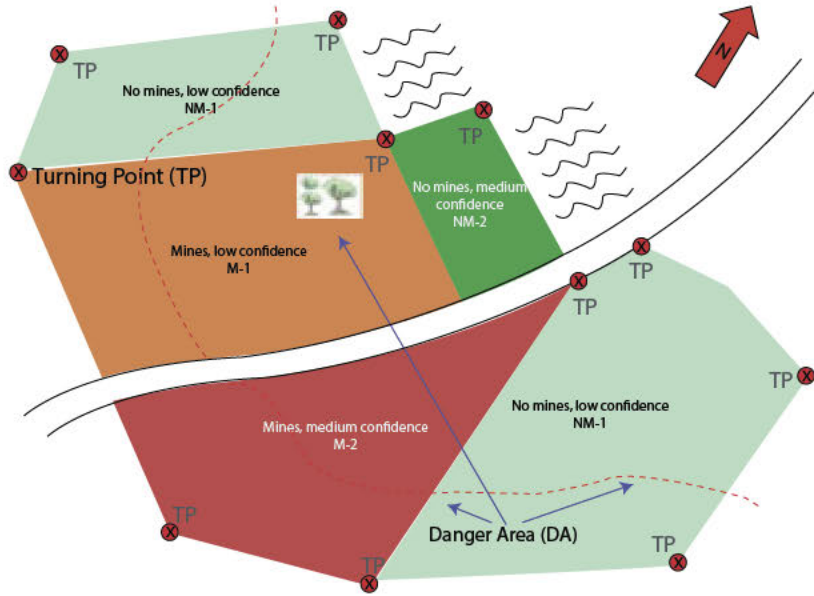


Figure 2. Example of a traditional CHA subdivided into five sectors.

Confidence Level	Required follow-up activity	Description of survey	Explanation
NM-3: No mines, high confidence	No technical survey before release	-	Condition for release of all land
NM-2: No mines, medium confidence	Limited technical survey before release	The lightest form of technical survey, typically applied to confirm that there are no mines in a sector	Release requires NTS/TS agreement
NM-1: No mines, low confidence	Normal technical survey before release	A more detailed technical survey, typically applied when the level of information is clearly insufficient or when the confidence in the information that there are no mines in a sector is insufficient	Release requires NTS/TS agreement
M-1: Mines, low confidence	Increased technical survey before release	A fairly comprehensive technical survey, typically applied to confirm the presence of landmines when the level of information is clearly insufficient or when the confidence in the information is low	Release requires NTS/TS contradiction
M-2: Mines, medium confidence	Extensive technical survey before release	A fairly comprehensive technical survey, typically applied to confirm the presence of landmines when the level of information is clearly insufficient or when the confidence in the information is low	Release requires NTS/TS contradiction
M-3: Mines, high confidence	Clearance of all or parts of CHA	-	Sector of SHA cleared (with buffer)

Table 1. Illustrates the degree of confidence in establishing a CHA as an output from NTS.

is scarce. Areas where a perceived, increased residual risk remains despite evidence-based survey revealing no actual evidence of contamination may be recorded as areas with restrictions (AWR). In the absence of such systems to delineate AWRs, CHAs are at risk of considerable inflation. It then becomes difficult to place reasonable restrictions on land use for the population or to outline the risk-reduction efforts required should the needs for land use change. Lifting restrictions is a reactive response requirement, similar to schemes implemented throughout Europe in order to manage residual risk of mines, CMR and other ERW from World War II. NPA promotes AWR recording because it could have a positive effect on the wider survey process and generate more accurate recording of CHAs.

The Broader Evidence-based Survey

Evidence-based survey involves the systematic collection and assessment of measurable evidence of the existence of mines/CMR in an area by NTS and TS. NPA's land-release methodology denotes the type and amount of TS required depending on the level and degree of confidence gained from NTS. Stronger evidence against the presence of mines/CMR reduces the affirmative evidence requirement for follow-up TS in order to release land.

Non-technical Survey

NTS collects essential information without the use of technical interventions in a specific area. NTS is usually a first step in order to determine evidence of the presence or absence of landmines and other explosive hazards while clearly distinguishing between mines, submunitions and other unexploded ordnance (UXO). Reasonably tight polygons should be drawn around areas with evidence of mines/CMR,

and these polygons should be divided further into practical sectors depending on the amount and quality of evidence in various parts of the CHA. Linear minefields can be split into smaller CHAs based on assessment of the terrain, perceived minefield patterns and other local features. A degree of confidence in each of the sectors being mined or mine-free should be established in order for minimum TS requirements to be identified following NTS for confident release of land.

Evidence-based division of CHAs into subsectors is preferably undertaken during NTS and takes advantage of the fact that within the wider CHA there may be varying degrees of evidence of the presence or absence of mines.¹ Typically one or several sectors of a CHA are more likely to be mined than other sectors. Checking these sectors first during TS—and finding evidence that fully corresponds with NTS results—increases confidence that the remaining sector(s) are free from mines. One part of a CHA may thus require considerable TS investigation while another part (or multiple parts) may only require small scale TS to justify release. In linear CHAs, the precise location of the sectors may only be possible to define during clearance. Each subsector is unique and requires a separate analysis of available evidence.

Technical Survey

TS is a detailed survey intervention with technical assets that can detect or reveal the presence of mines/CMR. It is usually integrated into the wider survey process and has four principal roles:

- Assist NTS in defining more accurate and thus smaller CHA polygons
- Define parts of CHAs that require clearance
- Investigate buffer zones around cleared areas
- Release land within CHA polygons

The real sources of information in TS are the mines/CMR in the ground and the information they can provide. Empirical experience from similar tasks and conditions helps determine the likelihood of mines being laid in patterns, the type of potential patterns and how many mines are typically found in similar conditions.

Targeted TS integrated with the initial NTS permits recording of smaller and more accurate CHAs. Inside a CHA the basic principle is to search the area until mines/CMR are located, which is where full clearance starts and proceeds to the front and sides, following the mine patterns if they exist. If no mines are found, sufficient TS must be applied to estab-

Type of asset	Assessment of quality of assets in TS	Probability of detection
Manual mine clearance	Manual mine clearance is considered the most accurate clearance and survey tool. All mines are normally found.	100%
MDD, two searches	IMAS defines dual search with animals as clearance.	100%
MDD, one search, low vegetation	Empirical experience and trials suggests that MDDs, if well trained, can find beyond 95% of all landmines but environmental variations could influence performance. NPA has depreciated the qualitative performance value by 5%.	90%
MDD, one search, high vegetation	If MDDs are deployed in areas with high vegetation, NPA depreciates the qualitative performance by another 10% awaiting results from on-going research.	80%
Flail and tiller	Performance will vary between operational scenarios. A tiller may identify a high percentage of certain mine types while missing most other mine types. Country and location specific assessments are thus required to define the role of machines in TS. Such assessments generally show a probability of detection between 40-80%.	40-80%
Rollers	Performance will depend on the ground and type of mines. Rollers will under some conditions detonate more than 40% of mines while less than 20% under other conditions.	10-40%

Table 2. Probability of detection by various methods; defined by assessing past tests, trials and empirical experience by NPA and other organizations. The values need to be agreed with the national mine action authorities and there may be variations between countries. Other assets can also be used and the table expanded.

lish high enough confidence that the area is free from contamination. There is a balance between probability of detection (quality) of an asset and the size of ground the asset needs to cover (quantity). If probability of detection is low, more ground must be covered to counterbalance the lack of quality.

Systematic and Targeted TS

Systematic investigation is a random approach (applied in a systematic manner), while targeted investigation addresses specific parts or spots within a CHA that are more likely to be contaminated than others (danger areas). Targeted investigation is preferred because it collects better information and thus requires smaller areas to be inspected. It should be applied when possible. If no danger areas can be identified, systematic investigation can be applied, but it provides less confidence in the survey outcome. The ground coverage

Probability of detection	Area multiplying factor	TS requirement (% default ground coverage) (manual mine clearance)									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
100%	1.00	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
90%	1.11	22.2%	22.2%	33.3%	44.4%	55.5%	66.6%	77.7%	88.8%	100%	-
80%	1.25	25%	25%	37.5%	50%	62.5%	75%	87.5%	100%	-	-
70%	1.43	28.6%	28.6%	42.9%	57.2%	71.5%	85.8%	100%	-	-	-
60%	1.67	33.4%	33.4%	50.1%	66.8%	83.5%	100%	-	-	-	-
50%	2.00	40%	40%	60%	80%	100%	-	-	-	-	-
40%	2.50	50%	50%	75%	100%	-	-	-	-	-	-
30%	3.33	66.6%	66.6%	100%	-	-	-	-	-	-	-
20%	5.0	100%	100%	-	-	-	-	-	-	-	-
10%	10.0	-	-	-	-	-	-	-	-	-	-

Table 3. Area multiplying factor when the probability of detection is segmented into 10 percent intervals.

requirement is usually around 30–50 percent higher when systematic survey is applied. Systematic investigation has several applications and limitations:

- It is applicable when the purpose is to locate pattern-laid or clustered mines or CMR strikes.
- It is normally applicable if the aim is to confirm that parts or all of a CHA are mine-free.
- It is less or inapplicable when areas are thought to contain only a few mines that are likely randomly distributed over large areas (e.g., as a result of local demining).²

Relationship Between NTS and TS

Understanding the relationship between NTS and TS permits a tailored and more efficient approach to the use of TS. NPA uses three degrees of confidence (high, medium and low) when determining whether an area is mined or mine-free. Table 1 (page 18) shows the degree of confidence in establishing a CHA as an output from NTS and how this can predefine the required degree of TS to justify the release of land. Four predefined levels of TS can be identified.

How NPA Conducts Technical Survey

Following the general land-release principles above, NPA has explored more efficient ways to conduct TS and improve land-release results. A range of different assets and combinations can be used. While also offering the highest possible search rates at the lowest costs, a good TS asset has a high probability of detecting evidence of mines/CMR. TS collects information in four principal ways:

- Audible detonation of mines (e.g., detonations from the use of flails or tillers)
- Physical detection of invisible mines (e.g., manual mine clearance, large loops, and mine detection dogs [MDDs])
- Visible debris of landmines (e.g., thrown-out mines from flailing or pieces of crushed mines)
- Visible or detectable evidence of mine casings, arming pins, etc.

The outcome from these combined processes are assessed and quantified to define the qualitative performance of different assets in TS.

Area Multiplying Factor

An area multiplying factor is deduced from confidence = detection probability x required ground coverage. NPA multiplies the factor with the default ground coverage outlined for manual mine clearance, which specifies required ground coverage when other assets are used. A reduced probability of detection yields a higher area multiplying factor. For example, one MDD needs to search only 1.11 times more ground to justify release than if manual clearance is used. The best cost/benefit ratio is thus achieved in TS when animals are used for single search and machines are used with no additional follow-up beyond visual inspection of the processed ground.

NPA's site managers may decide to cover more ground than is proposed in Table 3 if this is deemed more appropriate. There are also occasions where less ground coverage is

Asset(s)	Multiply- ing factor	Technical Survey							
		Limited targeted/ systematic		Normal targeted/ systematic		Increased targeted/ systematic		Extensive target- ed/systematic	
Manual demining	1	10%	20%	15%	30%	25%	50%	30%	60%
MDD, two searches									
MDD, one search	1.11	11%	22%	17%	33%	28%	56%	34%	67%
MDD, one search, high grass	1.25	13%	25%	19%	38%	32%	63%	38%	75%

Table 4. Minimum ground coverage requirements when using MDDs. Figures will be country specific and this table only provides an example of principles where, e.g., ground coverage for targeted TS is set to half of systematic TS. The table can be expanded to incorporate other assets.

justified. For example, NTS may contain detailed and reliable information about the number and type of mines in an area. If these mines are cleared before reaching the minimum requirement for TS, the rest of the CHA may be released with no further need for TS. Reasons for going below or above the minimum TS requirement are stated in the completion report.

The Field Approach

Under NPA's land release methodology, NTS is sometimes enhanced with elements of targeted TS, maintaining the aim of defining smaller and more accurate CHA boundaries. When TS is applied inside an already established CHA, NPA begins revising the sector division from the NTS by default and investigates the sectors that are most likely contaminated. Land may be released if the TS reveals no evidence of mines in the CHA sector.³ If the TS reveals evidence of mines, clearance is in principle conducted from the center of the mined area outwards. When no further mines are found, an additional buffer area is searched.

If mines are found by the TS in parts of the CHA that the NTS concluded to be mine-free, then the task is reassessed and sectors are reclassified to reflect the

changed situation. If mines are found in a sector that the NTS predicted to contain mines, remaining sectors may be reclassified to a lower TS requirement. A sector where the initial TS requirement was normal may then only require limited TS. A sector where the initial TS was limited may similarly be released. The system thus documents the justification for reclassification of sectors and final release of land, which is useful when national authorities conduct quality assurance.

Quality land release methodology is essential for any mine action operation. Through the use of both NTS and TS, land is evaluated. NTS serves as the first step in this evaluation. However, the requirement for TS is variable in different mine action contexts. Thus, TS should be tailored toward true needs in each area, which in most cases increases efficiency and decreases costs. General land release principles yield a scale of confidence to measure the extent of contamination. Assets with dissimilar detection rates compel varying ground coverage rates to produce the required confidence in the TS, exemplified in the area-multiply-ing factor. Scalable TS solutions, while slightly more challenging to develop, are fairly easy to apply in the field. ©

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Håvard Bach is based in Geneva and is chief technical advisor, operational methods for the mines and arms department of Norwegian People's Aid (NPA). His previous work includes head of the operational methods at the Geneva International Centre for Humanitarian Demining, head of global mine action operations for APOPO and a long-standing prior employment with NPA, where he established and managed mine action programs in Angola, Cambodia and Mozambique, among others.

Håvard Bach
CTA, Operational Methods
Mines and Arms Department,
Norwegian People's Aid (NPA)
963 Route de Bellevue
01280, Preveessin Moens / France
Tel: +33 450413936
Fax: +47 22200870
Email: hbach@npaid.org
Website: npaid.org

Managing Residual Clearance: Learning From Europe's Past

Lessons learned from residual clearance in post-1945 Europe may apply to long-term clearance efforts after more recent conflicts.

by Samuel Paunila [GICHD]

In light of current conflicts, it is easy to forget that many European countries still manage World War I (WWI) and World War II (WWII) explosive remnants of war (ERW) contamination. Over decades, these countries developed practices and policies that could help shape priority setting and risk management in countries more recently affected by ERW. Post-conflict countries could learn from the early mistakes in European responses and benefit from practical approaches that address residual threats at varying depths and with differing time frames.

The historical evolution of best practices since WWII can also assist countries in policy design beyond the fulfillment of commitments under the international *Convention for Cluster Munitions (CCM)* and the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction (Anti-personnel Mine Ban Convention or APMB)*. Understanding when to start and stop the implementation of proactive clearance serves as an excellent foundation for residual clearance policies.¹

Understanding Before Acting

One of the immediate challenges facing countries recovering from armed conflict is the prevention of further casualties from ERW contamination. After addressing immediate concerns, including protecting citizens and critical national infrastructure from explosive hazards, governments strive to secure safe environments for daily life and socioeconomic recovery.² With internal and external pressures in play, the following limitations often characterize this early stage:

- No time for planning comprehensive surveys
- Inadequate information on the scale and impact of ERW contamination
- Policymakers' inability to approach the threat of ERW through risk management.

As a result, some countries provided ambiguous estimates regarding years of ERW clearance required, adding to the confusion.³

From Proactive to Responsive

Responsible governments logically adopt a proactive approach to ERW during and immediately after armed conflict. Implementation usually involves a rapid survey covering large areas with clearance operations aiming for exhaustive eradication of ERW, at least in priority areas. With time and progress, these operations usually report a decline in ERW encountered and make priority and highly-contaminated areas safe from surface and shallow ERW. Meanwhile, institutional knowledge within the responsible authority improves on typology, extent and implications of the remaining contamination.⁴ With less ERW to address, the high costs of proactive clearance yields decreasing marginal returns and, in absolute terms, often debatable increases in public safety. The reduced threat from remaining ERW raises the need for the country to readjust its priorities and response policy to better reflect modern risk management.⁵

World War II Lessons

Several European and Asian countries experienced extensive and prolonged bombardments from air, sea and land during WWII, resulting in significant ERW contamination per square kilometer (247 ac) of territory.⁶ In fact, more than 30 countries continue to discover and clear WWII-era ERW. For instance, the U.K. regularly recovers deeply buried bombs from the greater London area. Many ERW remain at the bottom of the River Thames. Germany's experience of bombing during WWII was more intense and sustained, leaving a widespread legacy of surface and shallow contamination in cities and the countryside. Two million tons of ordnance were dropped, with an estimated 100,000 unexploded bombs remaining in present-day Germany.⁷ Up to 10 aircraft bombs are still found yearly in Berlin alone.

The intensity of the destruction in specific areas of the U.K. and Germany compares with the shelling and bombing of Laos and Vietnam, which began with the battle of Dien Bien Phu in 1954 and continued through the end of the Vietnam



Balham underground station in Southwest London after a raid on the evening of 14 October 1941, when 68 people died after pipes burst causing water and silt to fill the station.

Photo courtesy of Imperial War Museum.

War in 1973.⁸ Sixty years after the First Indochina War and 40 years since the war in Vietnam, the management of residual ERW in this region is highly relevant and could benefit from a fresh perspective and transfer of knowledge.

After WWII, European governments had to make major decisions on prioritization and public safety, assessing economies of scale in dealing with residual abandoned and unexploded ordnance. The primary regulator for the evolution of policies prior to establishment of the International Small Arms Control or International Mine Action Standards was common sense; not every square meter could or should be cleared in each area suspected of containing ERW. The contamination had to be treated differently depending on if the ERW was at the surface or buried. Economic and infrastructure pressures often resulted in release of land to the population before it was guaranteed that the land was safe to a specified depth. It was, and still is, every citizen's responsibility to be vigilant and report ERW findings to local authorities.

Evolution of Policies

Since 1945, countries' responses to ERW evolved through a series of reality checks. On the one hand, authorities had to weigh the extent and type of contamination with the *de facto*

danger to population and infrastructure. On the other hand, they needed to assess available technical and human resources, as well as their efficiency and associated costs. The reality of these competing priorities was no more apparent than in post-WWII London, where more than one million destroyed buildings needed to be rebuilt.⁹

The policies of that era were guided by early applications of risk management and implemented by experienced, yet often poorly equipped, operators and advisers. The first two decades after WWII could be described as a showcase of varying degrees of resilience in London and Berlin, learning from mistakes of unregulated work while pushing for new perspectives and procedures for ERW practices. During the 1970s, civil-reporting mechanisms became more effective by moving data from war archives to the first interactive information-management systems. The management of residual ERW soon evolved as a mechanism of shared responsibility with specified tasks for armed forces, emergency services, civil servants, citizenry, and more recently for commercial contractors.

Proactive, Reactive, Responsive

The U.K.'s early ERW response policies were primarily reactive, and Germany implemented a combination of



Locations of bombs reported to have fallen during the period of the London Blitz in and around the area of the London Olympic Park.
Photo courtesy of www.bombsight.org.

reactive and proactive policies. In both contexts, assessing, treating and reducing risk became a suitable approach to managing residual ERW. The policy implementation had to be transparent to the public, thus reflecting society's values while including liability aspects in light of decreasing public tolerance toward ERW casualties.

Present ERW clearance in European countries is largely responsive compared to operations conducted immediately after WWII. Many of the affected countries now operate on the premise that ERW contamination cannot be totally eliminated, but the hazards associated with remaining ERW can be mitigated through risk education, responsive local threat assessments and explosive ordnance disposal (EOD).¹⁰ This assumption of acceptance of long-term residual risk and differentiation between responses on surface, shallow and deep residual contamination starkly contrasts with the admirable yet abstract policies that continue advocating for total eradication of ERW.^{11,12}

Emerging countries that experienced major bombardments following the 1960s, such as Laos and Vietnam, completed most of their post-war reconstruction and now enter long-term development. However, some of their current contracting and budgeting modalities encourage continued proactive ERW clearance over less expensive survey activities, land-use assessments and risk reduction through spot EOD.¹³ Moreover, policymakers may overestimate the impact of ERW, in particular that of deeply buried bombs.¹⁴

For instance, the response requirements for ERW on the surface and at shallow depths vary significantly to that of the U.K.'s deeply buried bombs, wherein the latter are mitigated reactively by default. A good example of this policy's implementation is the construction project of the Queen Elizabeth Olympic Park in London prior to the Summer Olympic Games in 2012. The entire area was heavily bombed during WWII. Based on the bombing data, deeply buried ERW could emerge during the park's construction.¹⁵ A risk assessment deliberately avoided proactive clearance of the park. The level of preparedness was raised for the reactive bomb disposal. After an air bomb was recovered, an expert examined it and, as anticipated, was unable to pinpoint the implications of corrosion in the metal and explosive components. However, the expert was able to establish whether the bomb presented a danger in its current location and the extent of protective works needed.

Lessons Learned

Central to managing residual ERW is strong national ownership of risk and response, and well-performing authorities with solid understanding of liability, operational efficiency and risk management. ERW tasks are best suited to be the shared function and responsibility of civil defense and military that maintain the budgets and mobile-response capacity.¹⁶

Following the organizational structure, suitable information management and reporting systems differentiate between surface (and shallow subsurface) contamination and deeply buried bombs. Clearance of the former and other surface items with particular humanitarian impact are included in States Parties' obligations toward the CCM and APMB. Such surface items include cluster munitions banned by the CCM and anti-personnel mines banned by the APMB. Treaties do not ban other items such as mortar bombs and hand grenades, but they are dangerous and render a humanitarian impact if detonated.

Deeply buried bombs cannot be easily surveyed over large areas nor can communities readily identify them; often they become a challenge only after being discovered during construction and development activities. Therefore, most long-term contamination that does not pose immediate humanitarian danger could be addressed by adopting a risk-management approach and introducing more sustainable,

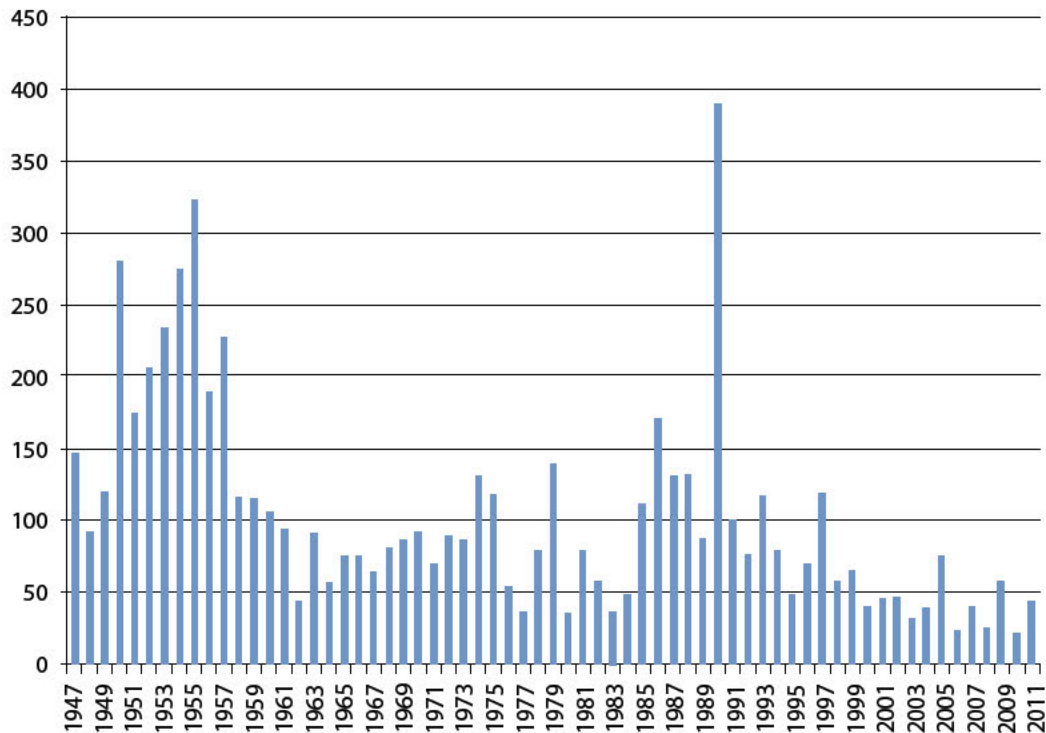



Figure 1. Annual quantity of UXO disposed of in West Berlin (1,000 kg), 1947–2011.
Figure courtesy of GICHD.

commercially viable response models. For financing institutions and donors, selecting such an approach would allow investment to focus on manageable and important tasks, not the all-encompassing clearance of countries.

Conversely, national authorities would be responsible for developing policies to manage long-term residual ERW. In such an environment, progress would be defined in terms other than the sum of square meters cleared and number of ordnance destroyed. Recent propositions for hundreds of years of continued ERW response in Laos and Vietnam should be significantly reduced by dissecting the contamination into its components and assessing the actual degrees of risk.

Lessons from the European WWII experience advocate moving away from proactive clearance practices and policies to responsive long-term survey and clearance mechanisms that are sustainable, proportional to the reduced threat

and appropriate to the intended use of the contaminated land. Adoption of such policies would enable efficient resource allocation while providing better developed perceptions of residual ERW and associated risks. 

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The Geneva International Centre for Humanitarian Demining (GICHD) began a study of post-1945 ERW response policies and practices in 2013, focusing on management of residual risks. The research project extends to 15 countries and serves to facilitate knowledge transfer and advise policymaking on residual ERW among national governments and donors. Beyond this study, GICHD assists in developing sustainable national leadership and capacities to confront residual contamination while increasing the role, and sharpening the structure of national security services in ERW response.



Samuel Paunila is an automation engineer and weapons systems technical officer. He serves as adviser for land release and operational efficiency at GICHD, interacting with mine action authorities and operators around the world on the development of effective policies and practices for surveys, operations and risk management. Previously, he worked for Danish Demining Group and the Finnish Armed Forces, leading programs in demining, bomb disposal, quality and stockpile management, and armed violence reduction in Afghanistan, Sri Lanka, Uganda and the former Yugoslavia.

Samuel Paunila
Advisor, Operations
Geneva International Centre
for Humanitarian Demining
Chemin Eugène-Rigot 2C
1211 Geneva 1 / Switzerland
Email: s.paunila@gichd.org

Environmentally Responsible SAA Disposal

The need to dispose of small arms ammunition (SAA) for short-term stability and security concerns has traditionally outweighed the long-term need for environmentally responsible disposal. The author suggests the international community should change its procedures concerning SAA disposal and promote more environmentally friendly disposal methods.

by Ian Biddle [G4S Ordnance Management Ltd.]

An estimated 750,000 arms-related deaths occur every year.¹ According to Amnesty International, conflict and armed violence kills 1,500 people daily.²

In 2006, the Bonn International Center for Conversions estimated that “hundreds of thousands of tonnes of surplus ammunition inherited from the Cold War are thought to be held in Albania, Belarus, Bosnia-Herzegovina, Bulgaria, Kazakhstan, Russia, Ukraine and Uzbekistan. The relevant U.N. office in Southeastern Europe has estimated surplus stocks of ammunition from only ten countries in the region as follows” [see Table 1].³

Albania	140,000 tons
Belarus	1,000,000 tons
Bosnia-Herzegovina	32,000 tons
Bulgaria	153,000 tons
Croatia	40,000 tons
FRY Macedonia	10,000 tons
Moldova	20,000 tons
Romania	100,000 tons
Serbia and Montenegro	100,000 tons
Ukraine	2,000,000 tons

Table 1. Estimated surplus of ammunition stocks from 10 countries in Southeastern Europe.³
Table courtesy of the author/CISR.

Additionally, the recent upheavals in the Middle East and Africa have littered the respective regions with small arms ammunition (SAA).⁴ Ammunition from these and other stockpiles leaked across international borders. Temporary munitions stockpiles established to support military operations, in which SAA is the longest lasting and most stable component, are often abandoned. Post-conflict, abandoned stockpiles are a principal source of ammunition for insurgents,

terrorists and criminals, and SAA is a major destabilizing factor in post-conflict situations.⁴ Reducing the availability of small arms, light weapons and SAA is a priority in all disarmament, demobilization and reintegration programs. According to an article by Oxfam International, “Ammunition supplies have an impact on the ability of combatants to engage in hostilities. A shortage of bullets can reduce or even stop fighting altogether ...”³

Disposing of Surplus SAA

Disposing of SAA is difficult in bulk. Expending ammunition through live fire is not viable if a stockpile consists of hundreds of thousands of rounds. Mechanical destruction requires the deformation of every cartridge. Burial is a popular form of caching SAA for later use, as it resists corrosion. Sea dumping is prohibited, as ammunition and explosives are considered hazardous industrial waste and fall under the remit of international treaties: the 1972 *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*; the 1996 *Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (amended 2006); and the 1998 *Convention for the Protection of the Marine Environment of the North-East Atlantic*.^{5,6,7}

The only viable method of bulk destruction is incineration through open burning (OB), industrial incineration or incineration via mobile incinerator.

Open Burning

In the past, the requirement of disposing surplus SAA quickly to promote stability and security overrode the requirement to dispose of SAA in an environmentally responsible manner. OB can produce atmospheric and terrestrial heavy metal pollution from molten bullet cores, which inevitably seeps into the food chain.⁸



Transportable SAA disposal system, Afghanistan, 2013.
Photo courtesy of Kenn Underwood.

According to an evaluation in Canada of heavy metal contamination after OB in 2001, "... small arms bullets contain a 98% lead, 2% antimony alloy ... Tracer rounds contain strontium, molybdenum, and carbon tetrachloride ... The incineration of these toxic materials can understandably lead to adverse environmental impacts. If burning is not tightly controlled, temperatures may easily surpass 525°C, the point at which lead begins to vapourise. Unless a robust filtration apparatus is used to scrub such emissions, lead-contaminated particulates will be released into the environment."⁸

OB in a pit or a burning tank is easy to implement using materials and technology readily available in less-developed countries. As a common form of field disposal, OB is suitable for SAA quantities of a few thousand rounds at a time, lengthening the process when a stockpile weighs several tons.

A number of OB techniques can destroy ammunition safely and efficiently. These include open-pit burning using specially built burning boxes, either static or mobile. Readily available materials, such as disused 50-gallon oil drums, provide excellent containers to burn SAA.⁹ Advantages include high production rates and very low costs. However, the container must cool for 24 hours before subsequent burns. The main disadvantage of OB procedures is ensuing air pollution.¹⁰

The theoretical incineration temperature is around 2,000 C (3,632 F), but this assumes perfect burning and complete stoichiometric conversion, and does not account for heat loss due to wind or other factors.¹¹

In practice, OB produces a dense smoke plume consistent with incineration at a lower temperature and similar to plumes found in house fires at about 600 C (1,112 F) instead of the 800 C (1,472 F) required to eliminate volatile organic compounds, which are major health hazards. Using relatively small samples, experiments have been conducted under controlled conditions and quickly rising temperatures. Under field conditions, a gradual temperature rise occurs with incomplete and inefficient burning. This produces the characteristic plumes of dense dirty smoke. OB is also slow. After burning, time lapse must occur before the pit or tank can be reused, limiting the number of burns to one per day and driving up costs. This is often ignored when attention is focused on the cost of equipment rather than the cost of the total process. Although the use of SAA burning tanks is cheap to initiate, the length of time required to dispose of a stockpile means that labor costs quickly escalate. Thus, the entire exercise can be more expensive and polluting than if a more expensive but productive incinerator had been used.

Industrial Incineration

Industrial SAA incineration avoids the pollution problems associated with OB. A kiln is preheated to a specific temperature to achieve complete stoichiometric conversion of the propellant; emissions are filtered and scrubbed; and there is no heavy metal pollution. As a continuous process, this allows for higher disposal rates while reducing the time needed to dispose of large stockpiles.

Industrial incinerators also have significant inherent disadvantages:

- Ammunition must first be collected and brought to the kiln.
- Establishing and operating the kiln has high costs.

High capital and running costs render the demilitarization of small SAA amounts ineffective, as disposal costs can easily reach several thousand dollars. Target costs for disposing (US\$800 per ton of SAA) can only be achieved using economies of scale, which dictate the collection of stockpiles to minimize logistic costs. Large stockpiles attract criminals and insurgents.¹²

The International Maritime Dangerous Goods Code has a complex process to classify goods for transportation. Munition classification is based on ammunition in the manufacturer's packaging. Ammunition recovered from the battlefield is frequently loose, making it very difficult to classify. As a result, shipping becomes a complicated, prolonged and expensive process.

Transportable Disposal Systems

Recently developed, self-contained, transportable incinerators can operate in remote areas where surplus SAA are often located, removing the risks associated with the consolidation of small stockpiles into large ones and eliminates the complications associated with transporting unclassified, dangerous goods. These systems are fitted with a comprehensive suite of pollution-control equipment, equivalent to that found in large static kilns. In addition, they generally have the same technology and scrap-processing systems found in large static facilities.

Recommendations and Conclusion

Africa and the Middle East have huge quantities of uncontrolled SAA, the availability of which is directly linked to the level of armed violence and

insecurity. Hence, disposing of this surplus SAA is a priority. As environmental responsibility is a major international concern, ammunition disposal should strive to adopt best practices.

Although easy to establish, OB causes severe, long-lasting, heavy metal pollution. The only environmentally responsible way to destroy surplus SAA is to use an incinerator fitted with pollution-control equipment. However, the dispersion of SAA stockpiles, high costs and time demands preclude the establishment of fixed industrial incinerators. In contrast, quickly deployable, self-contained, transportable SAA disposal systems fitted with pollution-abatement systems are available and may provide a more ideal solution. Transportable SAA disposal systems limit pollution and eliminate the need for difficult transportation efforts and the collection of large stockpiles.

On security and humanitarian grounds, disposing of surplus SAA should continue as an international priority since there is a strong direct correlation between the availability of SAA in a conflict area and the amount of small arms violence and an inverse correlation between SAA and the level of stability in a post-conflict region. However, the benefits of prompt disposal must be balanced against the legacy of atmospheric and ground pollution caused by current OB methods. As new technology enables prompt local disposal without pollution, OB should no longer be the default disposal method. Instead, use of transportable incinerators fitted with pollution-control equipment should be mandated when international and national bodies award contracts to dispose of SAA. ©

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Ian Biddle is the ammunition technical manager for G4S Ordnance Management Ltd. He has 30 years of experience in ammunition manufacture, sale, transportation and disposal, both in and out of the British army. He has worked in Bosnia-Herzegovina, Egypt, Germany, Iraq, Republic of the Congo, Sierra Leone and Somaliland.

Ian Biddle
Ammunition Technical Manager
G4S Ordnance Management
Southside
105 Victoria St.
London SW1E 6QT / UK
Tel: +44 207 963 3100
Fax: +44 207 834 6371
Email: ian.biddle@uk.g4s.com
Website: <http://g4s.com>

Conventional Munitions Disposal Capacity Development in South Sudan

The United Nations Mine Action Service is training members of South Sudan's National Police Service in order to develop a self-sustainable nationwide capacity for conventional munitions disposal in the country.

by Commandant Fran O'Grady [Defence Forces Ireland]

South Sudan's struggle to nationhood included two rounds of civil strife spanning almost 40 years (1955–1972 and 1983–2005)—the longest war in African history. With euphoria and high expectations, South Sudan gained independence 9 July 2011, but its split from Sudan has been difficult. Despite a massive influx of international aid, the nation remains one of the most impoverished and least developed in the world. The ongoing violence and intra-governmental fighting in South Sudan is deeply rooted in historical divisions, and power struggles continue among political protagonists.

Further, development statistics indicate that more than 50 percent of the South Sudanese live below the poverty line, national life expectancy is 42 years of age and maternal mortality is the highest in the world.¹ The Small Arms Survey notes that a 2006 survey recording 2,054 deaths per 100,000 live births may have been an underestimation.²

In addition, South Sudan inherited vast amounts of land contaminated by landmines and explosive remnants of war (ERW). As the South Sudanese address the monumental task of nation building, the need to clear these hazardous areas is a priority. In response, the United Nations Mine Action Service (UNMAS) began a three-year initiative in 2013 to train selected members of South Sudan's police service in order to establish a national capacity for conventional munitions disposal (CMD)—a joint project supported by the Irish Defence Forces, the United Nations Mission in South Sudan, the United Nations Police and the National Mine Action Authority.

Bridging the Gap

The desired end state for the UNMAS capacity development initiative is the establishment of a self-sustainable,



A CMD team member conducts a disposal task.
All photos courtesy of UNMAS South Sudan team.

nationwide CMD capability for the South Sudan National Police Service (SSNPS). To achieve this, trained police CMD teams must be available and deployable to all 10 states (with a total of 78 counties) in South Sudan. The goal is to field 78 teams, one for each county.

CMD Training

The eight-week pilot training of the first SSNPS CMD course commenced in mid-September 2013, and three teams deployed to the Greater Bar El Ghazal region (namely, Western Bar El Ghazal, Warrap and Lakes states) in early November. The course work of future CMD trainings will incorporate lessons learned from the pilot course (administrative, logistic and training). The plan is to conduct approximately four of these eight-week courses each year for three years. The best students from these courses will subsequently undertake train-the-trainer courses, thereby facilitating the handover for the responsibility for all CMD training to SSNPS in 2016.

One fundamental lesson learned involved the pace of instruction, which needed specific tailoring to the South



Members of the Irish Defence Forces training team brief students on the demolition range.

Sudanese context since many participants had limited education. The consideration of education levels, previous courses completed and language barriers was integral when determining the duration of the training. Student Charles Noon commented, “Before this course I had only primary school. These lectures and calculations are new to me and very difficult, but I am learning and my [weekly course assessment] results are getting better.”³³

This technical and difficult course could not be rushed if students were to thoroughly learn the material. The initial stages of the course demonstrated that strict adherence to length requirements for class periods may not be helpful. Instead, a more flexible approach to time management was adopted, which ensured that the students finished the class only after acquiring a firm understanding of the material. For instance, lessons originally planned for 40 minutes were allowed to last more than an hour to ensure that students grasped the concepts.

All lectures, lesson plans and tutorials were reconstructed to fit into a flexible timetable. The objective was to create an environment-specific training framework that would include tasks the teams might face during operations. By maintaining this continuous cycle of course review and refinement, the training program can evolve and succeed. UNMAS staff member and CMD operator Rambo Isaac is a South Sudanese national and works as a translator when needed. He says, “We are all [staff and students] learning every day on this course in our own different ways. This is a dangerous job that the

students are being trained to do and it is very important that the students and staff communicate well. The students must feel comfortable at all times to speak up if they don’t understand something. This is a two-way process.”³⁴

Typically, demining operations consist of large-scale, pre-planned deployments of demining teams that systematically clear defined hazardous areas over an extended period of time. This generally involves a significant logistical footprint as well as assets such as mechanical mine flails or tillers and mine detection dogs.

Although CMD operator and deminer skill sets overlap, SSNPS CMD teams are not structured, trained or tasked like demining teams. In contrast, these small CMD teams are meant to provide flexible, mobile and timely responses to unexploded ordnance (UXO) disposal requests in countries where they are based. For example, in the event that a mortar bomb is reported in a village, the local CMD team will deploy from its police station to the site, liaise locally, identify the hazard, cordon the area, dispose of the mortar, return to the police station and provide a technical report through the relevant channels.

Isaac captures the relationship between these discrete but interrelated functions: “The idea is that the demining teams and police CMD teams will complement each other operationally ... [t]hey are just different tools in the toolbox that hopes to fix the [mine and ERW] problem here in South Sudan.”³⁴

The course is based out of the Rajaf Police Training Centre, near the nation’s capital Juba. UNMAS funded and

constructed classroom facilities, training offices and demolition ranges in Rajaf to provide better facilities for course conduct. In line with the desired end state, this self-contained CMD training facility will be handed over to SSNPS in time, a move that will be made easier by its proximity to the activity center of South Sudan’s national police.

A Holistic Approach

While visiting the first SSNPS CMD course, UNMAS Director Agnès Marcaillou said, “We are training them [SSNPS] because the international community will not stay in South Sudan forever. The international community at some point will transfer the responsibility of this disposal and of the safety of its people to the country itself.”⁵⁵ The initiative is due to transfer by 2016.

UNMAS plans to first establish a solid CMD capacity before beginning a phased transfer of responsibility to SSNPS, with 2016 as a provisional handover date for full ownership of the training. To this end, a holistic approach was adopted that considers the actual CMD training and addresses issues such as field mentoring, standard-operation-procedures development, train-the-

trainer course conduct, administrative assistance, logistical support and technical guidance.

The Way Forward: Sustainability

In mid-December 2013, conflict erupted in South Sudan between pro-government and anti-government forces. Although talks between both parties have resulted in a signed ceasefire, ethnically fueled violence continues in parts of the Upper Nile region. However, the Equatoria and Greater Bar El Ghazal regions have stabilized. These events affected police CMD training, like many other capacity development initiatives in South Sudan. Rescheduling the second CMD course to commence in early April 2014 became necessary due to realities on the ground.

Nevertheless, SSNPS continues embracing the UNMAS capacity development initiative, and this future support is critical to its overall success. These UNMAS-led training courses for CMD teams are only the first step in this process. The police service must clearly understand the capacity under development, if it is to be resourced and tasked appropriately. The effective deployment of police CMD teams to communities

for the purpose of UXO disposal should remain the primary goal.

Real sustainability will require SSNPS to take full ownership of this project in the years to come and responsibility to meet the challenges that will indubitably arise. Col. Deng, senior officer and SSNPS contact for the initiative, says, “We [SSNPS] greatly welcome the Irish team. They work very hard and encourage us always to work hard as a team too. The instructors and students respect and support each other—we are in this together. They are teaching us everything we need to know to help clear UXO from South Sudan. We look forward to being responsible for conducting this training ourselves in a few years.”⁵⁶

UNMAS remains committed to working with the SSNPS to drive this life-saving, capacity development initiative forward with a view to deploying police CMD teams throughout South Sudan over the coming years. ©

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A student practicing CMD drills in a local village.



Commandant Fran O’Grady, a senior officer in the Irish Army Engineer Corps, is the leader of a conventional munitions disposal training team for the United Nations Mine Action Service in South Sudan. He received a Bachelor of Arts in mathematics, a Bachelor of Arts in engineering and a Masters in Science in engineering from Trinity College Dublin (Ireland). South Sudan is his fourth overseas deployment with the United Nations to Africa; his other deployments were to Eritrea and Ethiopia with the United Nations Mine Action Centre, and to Liberia and Chad for military peace support operations roles.

Commandant Fran O’Grady
 Defence Forces Ireland
 UNMAS, Camp Tomping
 Juba / South Sudan
 Email: fran.ogrady@defenceforces.ie

Lessons From Lebanon: Rubble Removal and Explosive Ordnance Disposal

The insight and knowledge gained from rubble removal and explosive ordnance disposal in the Nahr el-Bared Camp, which was destroyed during heavy fighting in Lebanon in 2007, could greatly benefit future reconstruction efforts in war-damaged urban areas.

by Erik K. Lauritzen [Lauritzen Advising]



Part of the war-damaged Nahr el-Bared Camp in northern Lebanon, prior to the start of the rubble-removal project (August 2008).

All photos courtesy of the author.

Clearing damaged buildings in densely populated urban areas is a high-priority in the reconstruction of war-torn countries. After long periods of intense fighting, the need for unexploded ordnance (UXO) disposal, combined with rubble removal, increases the challenge of rebuilding.

Clearance of war-damaged buildings, recycling of building materials and explosive ordnance disposal (EOD) were essential phases of past urban reconstruction projects. Prominent examples included Beirut after the 15-year civil war (1975–

1990), Sarajevo and Mostar, Bosnia-Herzegovina after the Bosnian War (1992–1995), and Kosovo after NATO intervention in 1999. In these locations, EOD units, specialized private groups or nongovernmental organizations (NGO) responded when rubble-removal contractors found UXO. Rubble removal ceased during the EOD projects but proceeded following EOD completion.

EOD organizations and rubble removal contractors cooperate through two different frameworks, depending on the level of contamination in an area. When the amount of UXO

found in the rubble is small or relatively low risk, on-call EOD support from teams or experts is the most efficient tactic. However, sometimes locations have high concentrations of bombs, mines, UXO or other sensitive explosive items. In this case EOD requires close support of experts or teams permanently on site. The reconstruction project in Nahr el-Bared Camp (NBC) was an example of this type of cooperation.

The NBC demonstrated how clearance can benefit from integrated rubble removal and EOD management in a post-conflict urban area. This camp offers insight for other post-conflict urban settings, including Syrian towns and cities currently experiencing heavy fighting near the Lebanese border such as Homs, An Nabk, Deir Attiyeh and Al-Qusayr.^{1,2}

Nahr el-Bared Clearance

In 2007, NBC was the center of severe fighting between the Lebanese Armed Forces (LAF) and the militant Islamist group Fatah al-Islam. The destruction of a densely populated area of roughly 200,000 sq m (50 ac) displaced approximately 30,000 people.³

The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) commenced a major reconstruction project in September 2008. UNRWA and the United Nations Development Programme (UNDP) entered into an agreement on the management of NBC's rubble-removal and EOD projects. Following this agreement, UNDP signed a fixed-price, time-constrained (with penalties for missing deadlines) contract with the construction and demolition company Al-Jihad for Commerce and Contracting S.A.L. for the safe removal and treatment of approximately 500,000 cubic m (6,539,800 cubic yd) of rubble and waste material in an environmentally sound manner during an 18-month period. For EOD, UNRWA and Handicap International (HI) entered into a contract, which provisioned four EOD teams to search and clear all explosive items on-site in the above-ground rubble. HI performed the EOD operation according to the International Mine Action Standards (IMAS); HI's methods and procedures were approved by the Lebanese Mine Action Centre (LMAC).

The EOD contract was based on an assessment made by MAG (Mines Advisory Group), which revealed heavy UXO contamination in the northern area (red portion of Figure 1). Furthermore, LAF stated that during the fighting in 2007 four or five air bombs were dropped and not detonated in the NBC red zone.

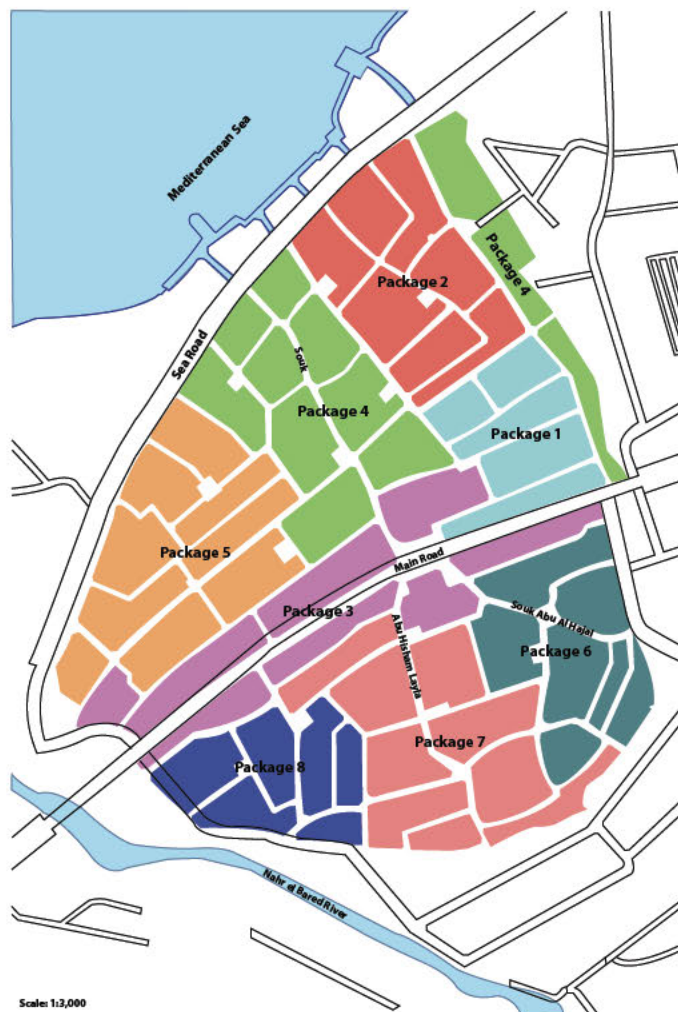


Figure 1. Outline of the planned reconstruction of 20 ha (50 ac) divided into eight packages, starting with the reconstruction of package one, progressing in numerical order and ending with the completion of package eight. Figure courtesy of UNDP and UNRWA.

The rubble-removal project aimed to integrate and optimize the work processes of the two contractors as quickly as possible. Success was determined as safe rubble removal and UXO clearance according to UNRWA's time schedule and the NBC reconstruction project. Contractually, NBC's reconstruction project was independent of the rubble-removal and EOD projects. However, reconstruction was contingent upon the time frame of the other projects and could not commence until completion of EOD and rubble removal.

The rubble removal and UXO-clearance project started in September 2008. The two tasks were done simultaneously and the project was completed on schedule in October 2009. The monitoring took place from the start of the project to September 2009, approximately one month before the end of the project.

Integrated Rubble Removal and EOD Process

The integrated rubble removal and EOD work involved

- Demolishing structures on and removing rubble from work sites
- Loading rubble onto trucks and transporting it from the work site to the laydown area for final inspection and additional UXO survey⁴
- Transporting rubble declared free of explosives by HI to the final disposal area

Each of HI's four EOD teams included a team leader and four UXO operators. The EOD and rubble-removal teams worked together to remove all rubble layer by layer and clear UXO until the terrain's surface was reached and cleared. The following procedures were used:

- EOD teams visually surveyed the work area before entering.
- UXO was removed and/or marked for destruction on site.
- The rubble-removal team used machines to gradually clear the area to the natural ground level, stopping for

UXO removal or destruction as needed.

- At the natural ground level, the EOD team performed a survey of the newly exposed surface.
- Any additional UXO found was removed or destroyed, and remaining rubble at the natural ground level was removed.
- HI certified the surface UXO clearance and LMAC approved the clearance in accordance with IMAS.

EOD team leaders moved UXO considered to be safe to a central UXO demolition site in an open concrete bunker and destroyed it by detonation. UXO considered unsafe to move was destroyed on-site. On-site detonation temporarily closed the area, stopping all activities and resulting in worker evacuation.

By the end of the work in September 2009, a total of 11,348 items were found. Excluding weapons and small-arms ammunition, approximately 2,500 (22 percent) were hazardous explosive items. Figure 2 and Table 1 present UXO details and distribution.

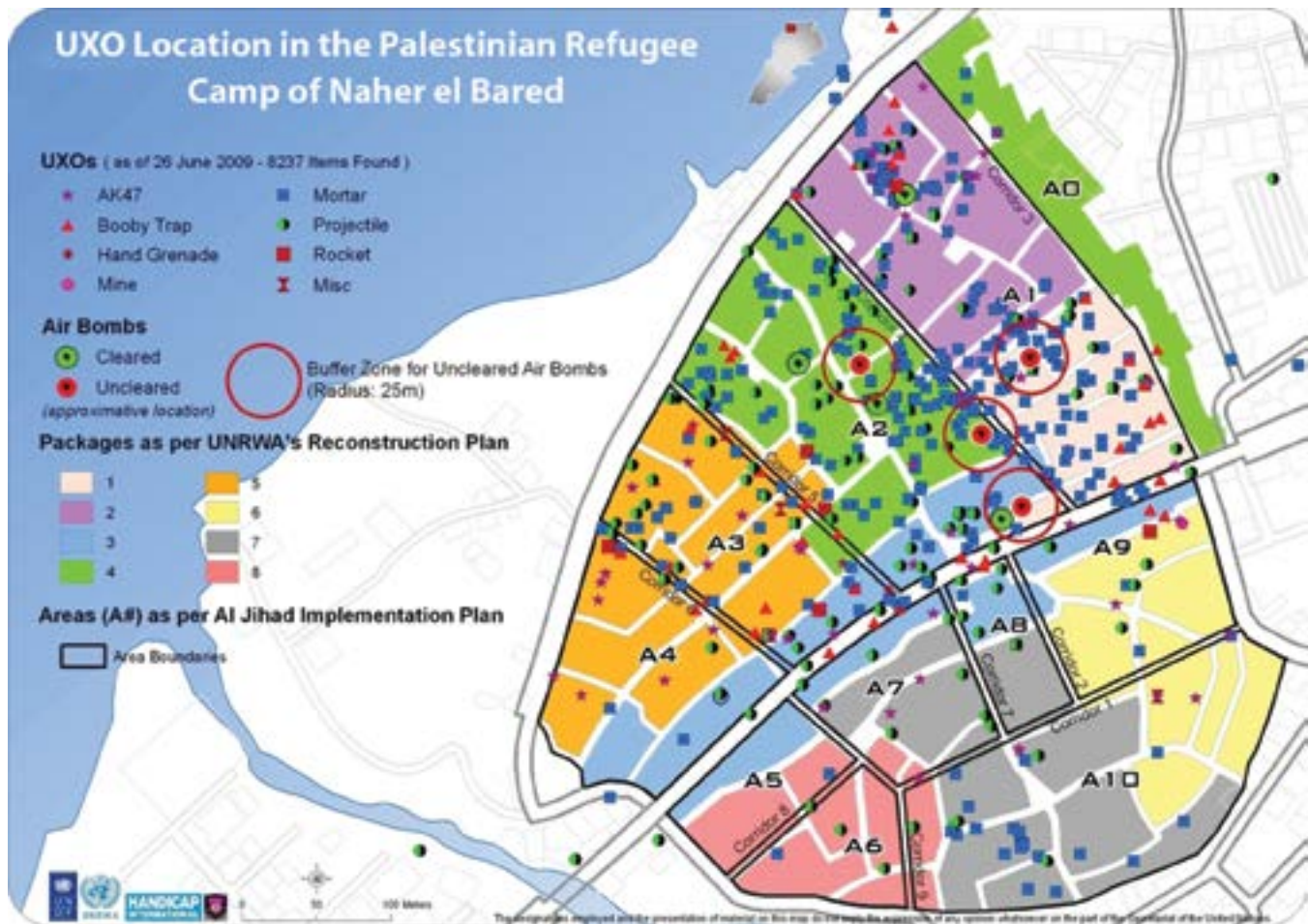


Figure 2. Sketch of NBC indicating location of UXO found in the Palestinian Refugee Camp of Naher el Bared by the end of August 2009.

Figure courtesy of UNDP, UNRWA and Handicap International.

Cooperation and Conflicting Interests

The contractual setup, including the decision to split the rubble-removal contract and the EOD contract into two independent contracts, proved crucial during the project implementation. All partners expressed the importance of proper coordination between the rubble-removal contractor and the EOD contractor to ensure NBC’s successful recovery and reconstruction. However, at the project’s inception, the partners did not fully understand the methodology of cooperation and team building essential to working in the field.

The EOD contractors’ prioritization of safety in a time-variable contract and the rubble-removal contractor’s prioritization of work speed due to a fixed-price, time-restricted contract were in disaccord, causing frustration and conflicts of interest throughout the project. The rubble-removal contractor allegedly did not understand the requirement of armoring the machines and providing personal protection equipment for demolition workers. Moreover, the EOD contractor often claimed that the rubble-removal contractor’s

personnel did not respect the safety rules. Additionally, due to the safety-distance requirements for rubble removal, allocating work for all four EOD teams on the site was difficult. As a result of positive dialogue, the two partners found a suitable modus operandi on a daily basis respecting safety and work performance to successfully complete the project.

Security, Health and Safety

The project’s successful implementation depended on overall security in north Lebanon. During the implementation period, the situation was calm: No serious incidents occurred with no negative environmental impact on the work. According to the UNRWA-UNDP agreement, UNDP and UNRWA were responsible for the safety and security of the UNDP project-management unit. UNRWA was responsible for the safety of all UNDP staff on a daily basis within NBC, while UNRWA managed the relationship with NBC authorities, including the military and the EOD contractor. UNDP was responsible for the planning and management of health and safety on-site.

AMMUNITION TYPE	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
Rifle grenades	12	111	184	197	125	89	68	89	90	49	48	32	1,094
Hand grenades	3	21	46	42	28	21	13	12	18	12	4	5	225
Projectiles	4	40	42	24	28	13	14	12	5	9	12	9	212
Mortar shells	6	57	95	80	88	53	26	40	27	35	31	22	560
Rockets	0	3	2	1	1	2	0	0	0	0	1	1	11
Bombs	0	0	0	1	1	2	0	0	0	0	0	0	4
RPGs	0	2	8	5	3	1	1	0	8	0	2	1	31
Mines	0	4	4	0	2	0	2	5	0	0	5	1	23
Fuzes	0	10	13	47	23	8	14	25	20	23	9	5	197
Small-arms ammunition	0	190	404	636	2,122	573	314	295	1,352	1,134	1,180	416	8,616
Miscellaneous	0	8	38	44	77	9	6	1	12	1	58	0	254
Weapons	1	5	6	13	22	6	21	3	6	19	13	6	121
Total	26	451	842	1,090	2,520	777	479	482	1,538	1,282	1,363	498	11,348
Booby traps	1	14	17	9	3	2	3	6	1	5	5	5	71

Table 1. Items of UXO found each month according to Handicap International’s report from October 2008 to September 2009. Table courtesy of author/CISR.

Success Criteria

- The rubble removal shall be completed in such a way that the respective areas are cleared and ready for construction works in accordance with the reconstruction project's time plan.
- Neighbors must be satisfied, and the number of claims by neighbors must be low.
- No serious accidents should occur.
- The greatest possible amount of rubble will be recycled and reused for the benefit of the NBC reconstruction project, and the smallest possible amount of materials will be disposed of at public landfill sites.
- The project should deploy a large number of local, NBC people.
- No negative discussions should be in the media.
- No additional costs should be incurred.

Figure 3. Success criteria of the NBC rubble-removal project.
Figure courtesy of the author/CISR.



Figure 4. NBC risk assessment by MAG. UXO-contaminated zones: Red area—heavy density (50 to 125 units of UXO per hectare) and possible five unexploded 250 kg air bombs; Amber area—normal density (13-49 units of UXO per hectare); Green area—light density (6-12 units of UXO per hectare).
Figure courtesy of MAG, Risk Assessment Report, April 2008.

The rubble-removal contractor presented a comprehensive health-and-safety plan, which included occupational health and work-safety precautions.

The EOD contractor was responsible for overall EOD and rubble-removal safety and managed the risk of uncontrolled UXO detonation in accordance with IMAS.

LAF controlled access to NBC and supervised on-site activities. The access procedures were somewhat problematic at the start of the project; however, thanks to very successful cooperation between the project partners and LAF, the daily work on-site ran smoothly throughout the project's duration.

Because of the high risk of uncontrolled UXO detonation, the EOD teams and the rubble-removal teams followed specific requirements in accordance with LMAC's accreditation of the EOD contractor's work procedures. The most important safety rules were as follows:

- All personnel on the work site were required to wear personal protective equipment, which included a helmet with an eye screen and a body vest.
- All machines operating on-site needed protection with armor and safety glass.
- The required safety distance between the machines and teams was 100 m (109 yd).
- The required safety distance between unprotected personnel and machines was 250 m (273 yd).
- All personnel working on site were provided information and UXO awareness training by the EOD contractor.
- Before entering the site, all personnel were required to report to the EOD contractor's checkpoint and be registered.

During the rubble-removal project, uncontrolled UXO detonations caused seven accidents. One was very serious: A detonation hit two rubble-removal workers who were sorting waste and rubble. One of the workers was severely wounded, hospitalized for several days and was unable to work for five to six months. All critical accidents took place within the project's first four months. No accidents were reported after February 2009.

Besides the accidents, a total of eight uncontrolled explosions were reported, but they did not cause injury. The incidents involved small explosive items, such as hand grenades. These items detonated either when machines hit undiscovered UXO or during loading or unloading of rubble (i.e., when UXO in the rubble fell to the bottom steel plate of a truck).

Four air bombs (two 250-kg and two 400-kg bombs) were found and handed over to LAF. Considerable efforts were made to find the fifth bomb, but documentation of reported unexploded bombs was very poor. It was concluded that only four bombs were among the rubble.

Lessons Learned

The NBC rubble-removal project demonstrated that clearing war-damaged buildings containing UXO is both challenging and risky. Seven accidents and eight uncontrolled detonations during the clearance of the 200,000 sq m (50 ac) urban area were reported.

Splitting the overall rubble-removal project into two separate contracts—a fixed-price, rubble-removal contract and a time-variable, EOD contract—was not appropriate. The project setup with respect to the cooperation between the two contractors was problematic, especially regarding safety-measure planning and control, such as maintaining



Deminers search for UXO amidst concrete rubble and iron bars.

safe distances, wearing personal protection equipment, etc. In the future, it is recommended that rubble-removal contracts and EOD contracts be merged, either with a shared set of contractual conditions or linked together under full control of one project manager.

Further, rubble removal and EOD are based on different working cultures. Rubble-removal, demolition and building-waste management are part of the construction sector, while EOD has roots in the military sector and is performed under the terms of the emergency or development sector. The two work routines and cultures should be integrated at all levels. Emphasis should be placed on team building and mutual understanding between the two contractors in order to avoid conflicts of interest regarding speed and safety.

The history and timing of the NBC rubble-removal project demonstrated that this type of project requires detailed and careful planning together with highly professional project management and control.

Recommendations

Removal of destroyed buildings contaminated with UXO requires integrated management of rubble-removal work and EOD work. Mutual understanding of the work and associated risks, together with open cooperation between the two types of contractors, is

a mandatory precondition for an effective and successful result.

Establishing the complete project organization at the project's start is required, and all planning documents, including work plans, health-and-safety management plans, as well as the quality-management plan, must be available from the beginning. ©

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Erik K. Lauritzen, managing director of Lauritzen Advising since 2008, is the founder of DEMEX Consulting Engineers, now NIRAS DEMEX, and has worked in the field of post-war and disaster reconstruction and demining for more than 30 years. He has worked with blasting and ammunition since 1980 and with post-war reconstruction and demining since the Balkan crisis in the early 1990s. Lauritzen holds a Master of Science in civil engineering, is a Lieutenant Colonel (reserve, retired) and was a member of the international mine action review board from 2005 to 2011, representing the Danish Ministry of Foreign Affairs and donors.

Erik K. Lauritzen
Managing Director
Lauritzen Advising
Egernvej 16
Frederiksberg / Denmark
Tel: +45 30 633 905
Email: ekl@lauritzenadvising.dk
Website: www.lauritzenadvising.dk

Applying NGO Resource-mobilization Strategies to the Mine Action Community

Due to funding concerns, the mine action sector is shifting its approach to resource mobilization and allocation. Emerging funding trends suggest that it would be advantageous for mine action centers and nongovernmental organizations to increase sustainability by seeking financial and technical support from a variety of sources.

by Dane Sosniecki and Suzanne Fiederlein [CISR]

Mine action centers (MAC) and nongovernmental organizations (NGO) are re-evaluating the ways in which they procure financial and technical support due to concerns regarding the future prospects for donor support to mine action. Although international funding for mine action has remained relatively stable since 2006, the weak global economic recovery and competing demands have funders reassessing how to allocate resources more effectively.¹ As a result, the mine action sector is undergoing a paradigm shift in its approach to resource mobilization and allocation. More emphasis on seeking nontraditional revenue sources, integrating mine action objectives with greater development goals and leveraging existing resources are now regularly touted as ways to manage increasingly scarce resources. Reviewing best practices from nonprofits, NGOs and other civil-society organizations in larger, more traditional fields may assist the mine action community in enhancing its resource-development strategies and ensure its continued relevance in the wider humanitarian sector.

Funding Trends in Mine Action

International assistance for mine action continues to fall short of what affected states request. In 2012, nearly US\$500 million was provided in international support. However, according to the Geneva International Centre for Humanitarian Demining (GICHD), the total cost of extensions to Article 5 of the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBC)—which obliges States



With not enough safe land available, local people often have no choice but to risk living and working near mine fields.

All photos courtesy of Sean Sutton/MAG (Mines Advisory Group)

Parties to clear all known mined areas within their initial 10-year signing period—is estimated at \$2.78 billion from 2009 to 2019. This number represents more than half of the total funding international donors provided from 1992 to 2008.^{1,2}

Moreover, according to the International Campaign to Ban Landmines, a lack of adequate engagement and political support by donor and affected states creates a disconnect between the amount of dollars spent on mine action and the level of progress on the ground, thereby harming the prospects of increased international support.³

The fiscal year 2015 budget request for the U.S. Department of State's Conventional Weapons Destruction program, managed by the Office of Weapons

SPECIAL REPORT

Removal and Abatement in the Bureau of Political-Military Affairs (PM/WRA), is \$127,595,000, representing a near 20-percent decrease in resources from fiscal year 2010.⁴ MAG America, cognizant of these trends, acknowledged that it expects funding from government sources to decrease in coming years. One of its top strategic priorities is diversifying its funding base and increasing unrestricted income.⁵

Thus, a rising trend toward a more efficient, performance-based mine action sector is developing. According to GICHD, stakeholders are less willing to fund or support activity without a measurable positive impact on affected communities or accept time-consuming, expensive mine-clearance work in areas that do not prove to contain mines.⁶

With traditional funders becoming more hesitant to back costly mine action activities, MACs and mine action NGOs must modify the nature of their dependencies and broaden the scope of their key development inputs to include more nontraditional sources. The process of reviewing best practices for NGOs seeking resource diversification in more established fields can facilitate new diverse resource streams. Such tactics are potentially transferable to MACs and NGOs in the mine action field. By adopting a variety of these strategic responses and adapting them to a mine action context, MACs can successfully navigate the changing economic environment and achieve sustainable resource dependency.

The Importance of Resource Diversity

Academic literature on transnational NGO-funding strategies—much of which is applicable to various actors in the mine action field—confirms that forming strategic partnerships with a diversified selection of resource providers helps alleviate the consequences of resource scarcity.^{7,8,9} According to resource-dependency theory, an organization is subject to external control when it depends on its external environment for a large proportion of a critical resource, such as funding. In his article “Strategic Responses to Resource Dependence Among Transnational NGOs Registered in the United States,” George Mitchell argues that the competition for increasingly scarce financial and technical resources may cause NGOs to become more donor-driven instead of need-driven, causing them to misalign their missions with donor preferences—which can lead to goal displacement, mission creep or mission vagueness. Ultimately, the pursuit of financial security forces NGOs to abandon their primary mission.⁷



Defused anti-personnel mines are sorted before being destroyed in a controlled demolition.

In the most extreme cases, a lack of diversified revenue streams can devastate an organization, such as the closing of Survivor Corps in 2010. The abrupt cancellation of a major grant from the U.S. Department of Health and Human Services—a funder that had consistently supported Survivor Corps since 2000—triggered the organization’s decision to cease operations. The enormous pressure put on its annual budget by the grant’s termination (and the 2009 economic crisis) forced the organization to formally close its doors.¹⁰

Such outcomes can be avoided if MACs and mine action NGOs diversify dependencies. By adopting a holistic range of strategic responses used regularly by transnational NGOs, MACs can ensure continued relevance and survival in their operating environment. Such tactics include⁷

- **Resource diversification:** Diversify funding bases to include private contributions, government funding and earned-income activities to achieve less revenue volatility. For instance, in 2010, the Lebanese Mine Action Center successfully entered a strategic partnership with Lebanon’s largest bank, BLOM Bank, and received a percentage of cardholders’ annual fees and retailers’ transaction fees to fund mine clearance activities.¹¹
- **Alignment:** Adjust an organization’s focus to suit more nontraditional donor preferences. Mozambique’s partnership with the United Nations Partnership to Promote the Rights of Persons with Disabilities Multi-Donor Trust Fund represents one such cross-sectorial approach that enables MACs and mine-related NGOs to accomplish their goals with nontraditional funding.¹²

- **Perseverance:** Secure grants and contracts simply to maintain cash flow, also known as “bridge funding.” Since 1994, the Voluntary Trust Fund for Assistance in Mine Action has provided resources for mine action projects or programs in situations where funding is not immediately available.¹³
- **Subcontracting:** Change from a mission-driven organization to a contract-driven one in an effort to secure substantial resources from large funders. In countries where landmines have been eclipsed as a funding priority, MACs and related NGOs have expanded their purviews by encompassing more prevailing issues into their fold, such as weapons and ammunition security, thereby essentially becoming more contract-focused instead of mission-driven.¹⁴
- **Specialization:** Different from others with a core competency in a specific programmatic area characterized by high donor demand and relatively low organizational supply. The Center for International Stabilization and Recovery represents one organization that leverages its academic relationships at James Madison University to provide high-level management training to senior mine action managers around the globe.

When the international community met in Cartagena, Colombia, in 2009 to reaffirm the commitment of States Parties, international organizations, and civil society to achieve a mine-free world, the Cartagena Action Plan was adopted with the aim of supporting enhanced implementation and promotion of the APMBC. Thus far, its implementation has reflected the more pragmatic realities of an increasingly resource-scarce and results-based field and has incorporated many of the strategic responses discussed previously.

According to the latest Geneva Progress Report, some emerging themes from the Cartagena Action Plan include:

- Raising national funds and seeking alternative funding sources from a wide range of international sources, including the European Commission, United Nations Trust Funds and the NATO Partnership for Peace Trust Fund.¹²
- Forming more strategic partnerships between States Parties in the APMBC to ensure resource sustainability and to overcome capacity constraints, such as the partnership between Mozambique and Norway aimed at an efficient completion of Article 5 obligations.^{3,12}



A deminer works in a field adjacent to a working farm in Angola.

- Creating greater synergies for technical assistance and information exchange between non-affected States Parties and affected States Parties in the APMBC, such as GICHD’s Arabic Language Outreach Programme.¹²
- Increasing South-South cooperation to leverage existing resources and enhance cost-effectiveness, such as the Laos-Cambodian South-South Cooperation Workshop on UXO/Mine Action Sector (supported by the Japan International Cooperation Agency).^{12,15,16}
- Improving national ownership of mine action activities, including good management and coordination, solid planning and clear reporting, such as Peru’s work to increase national budget expenditures on implementing plans and programs for persons with disabilities including landmine and other explosive remnants of war survivors.^{12,17}

Moreover, these emerging themes and strategic responses are not exclusive to States Parties of the APMBC. PM/WRA has long been a proponent of developing strategic partnerships through its Public-Private Partnership Program. With over 65 members in the program, PM/WRA engages with various NGOs, foundations, and civic, religious and educational groups to raise awareness, facilitate private contributions and foster cooperation between the private sector and affected countries in support of humanitarian mine action and efforts to control or destroy illicit conventional arms.¹⁸

Further evidence that these themes are beginning to take root has emerged in Southeast Asia where locally based NGOs in Cambodia, Laos and Vietnam have made

significant strides to forming a community of collective mine action despite significant political and bureaucratic obstacles. In her article in *Global Society* on building communities of practice, Julie Gilson notes that, given the increased competition and the need to be more efficient in their resources, there was increased incentive for these NGOs to form strategic partnerships as it helped better their responses to the demands of the environment.¹⁹

These partnerships are still nascent, according to Gilson, as cooperation between these NGOs has been purely functional, driven by experiences, subject matter, the issue in question, personal ties, the immediate locality, and the collective realization that resources can be used more effectively. In many cases, meetings are held strictly as a desire to “see what other groups are doing,” but technical information exchange and resource sharing have also occurred.¹⁹ Nevertheless, such partnerships that leverage funding and technical support represent a new norm in the mine action field and will become even more necessary as organizations are forced to navigate the increasingly turbulent environment.

Conclusion

Given the emerging funding trends in the mine action sector, it would be advantageous for MACs and mine action NGOs to become more sustainable by seeking financial and technical means from a variety of sources. A review of the current literature on NGO responses to resource dependency suggests this can take many forms, some of which have become clearly evident in the mine action community in recent years. In particular, the Cartagena Action Plan urges MACs and NGOs to form more strategic partnerships, leverage existing resources and employ tactics already being advocated by PM/WRA through its Public-Private Partnership Program. Evidence from the field also suggests diversifying streams of revenue by including private contributions and aligning organizational focus with nontraditional funders have been utilized. Regardless of the tactics taken, MACs and mine action NGOs must become serious about resource development as their continued relevance and place in the changing mine action sector is increasingly at risk. ©

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Dane Sosniecki is a research and editorial assistant for *The Journal of ERW and Mine Action* at CISR. He is earning his Master of Public Administration, specializing in strategic planning for international stabilization and recovery, from James Madison University (JMU). He graduated Phi Beta Kappa from JMU in 2010 with a Bachelor of Arts in political science. An AmeriCorps National Civilian Community Corps alumnus, Sosniecki will begin serving as a Peace Corps volunteer in Liberia mid-2014.

Dane Sosniecki
Editorial Assistant
Center for International Stabilization and Recovery
James Madison University
800 S. Main Street, MSC 4902
Harrisonburg, VA 22807 / USA
Tel: +1 540 568 2718
Fax: +1 540 568 8176
Email: cisr@jmu.edu
Website: <http://cisr.jmu.edu>



Dr. Suzanne Fiederlein joined CISR in 1999 and served as senior research associate and victim assistance team leader before becoming associate director in 2010. She has worked on projects related to victim assistance, International Mine Action Standards, mine risk education, mine action in Latin America, mine action database systems (specializing in casualty data), and program evaluation. In addition, she has coordinated the curriculum for CISR's Mine Action Senior Managers Course. She holds a master's degree in Latin American studies from the University of Texas and a Ph.D. in political science from the University of Arizona. She has served on the faculty of James Madison University and Virginia Commonwealth University. Her fields of academic research include refugee policy, international law and organizations, and Latin American politics.

Suzanne Fiederlein, Ph.D.
Associate Director
Center for International Stabilization and Recovery
James Madison University
Tel: +1 540 568 2718
Email: fiedersl@jmu.edu

Quality Management Systems in Mine Action Programs

The United Nations Mine Action Service in the Democratic Republic of the Congo (DRC) is in the process of implementing a new quality management system (QMS) for mine action in DRC. The QMS was implemented in July 2013 and its progress continues to be carefully monitored each quarter.

by Pascal Simon and Stefan De Coninck [UNMAS-DRC]

The United Nations Mine Action Service (UNMAS) in the Democratic Republic of the Congo (DRC), established national standards and quality assurance (QA) and quality control (QC) policies for mine action and implemented a quality management system (QMS) in May 2011 based on the International Mine Action Standards (IMAS) guidelines. Key quality processes, such as accreditation, monitoring and post-clearance inspection, follow the IMAS guidelines.

However, the implementation of the QMS at the grass roots level was not uniform. The reasons were obvious: Many inconsistencies in applying QMS could be attributed to a dynamic program with frequent changes in personnel, whose backgrounds and experiences varied, and changes in the locations of teams as they moved for different clearance operations. To address these challenges, UNMAS-DRC decided to examine the QMS rather than the personnel implementing the system.

After review, UNMAS-DRC found that one of the core reasons for noncompliance with QMS was the perception that the system was an “add on” to operational work. Staff did not find a link between the increase of quality management (QM) and the strengthening of operational procedures.

As a result, UNMAS-DRC sought to integrate QMS into daily operations so that it would no longer be perceived as a separate task. This required an objective means of measuring compliance with the system. UNMAS-DRC chose to implement a balanced scorecard (BSC) system, which had been successfully implemented in other UNMAS programs, such as in Afghanistan. In the BSC system, each office or organization receives a weekly score based on the accuracy and timeliness of their reports and on external and internal QA requirements. In addition to measuring compliance of mine action organizations, the BSC measures compliance of UNMAS-DRC regional operational offices.

To help implement the BSC system, UNMAS-DRC requested the assistance of the Swiss Armed Forces’ Explosive Ordnance Disposal (EOD) Centre, which provided a QM adviser. Together, the Swiss QM adviser and UNMAS established a QM board consisting of UNMAS operations and program section representatives to ensure agreement on all proposed actions and changes.

Objectives

The starting point for any QMS is the senior management’s policy on QA and QC. The previous UNMAS-DRC QM policy did not take into account changes in goals for the DRC program, which are now guided by the recently adopted national mine action strategy and national legislation. In 2002, the DRC government signed the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBC). In 2008, a national focal point structure was created within the Ministry of Interior to handle mine action in DRC. Parliament passed mine action legislation in June 2011. A key component of these developments, which needed to be included in the new QMS, was the aim to transition capacity for the planning, tasking and coordination of all mine action activities in DRC from UNMAS to the *Centre Congolais de Lutte Antimines* (Congolese Centre for Mine Action or CCLAM).

After reviewing the previous QM policy drafted in 2010, the QM board approved a QM policy in January 2013 with three main objectives for the mine action program:

1. Ensure that UNMAS-DRC activities maintain a consistent level of quality, meet all legal requirements and comply with United Nations Office for Project Services (UNOPS) policies and international standards related to mine action, such as IMAS and the *International Ammunition Technical Guidelines*.

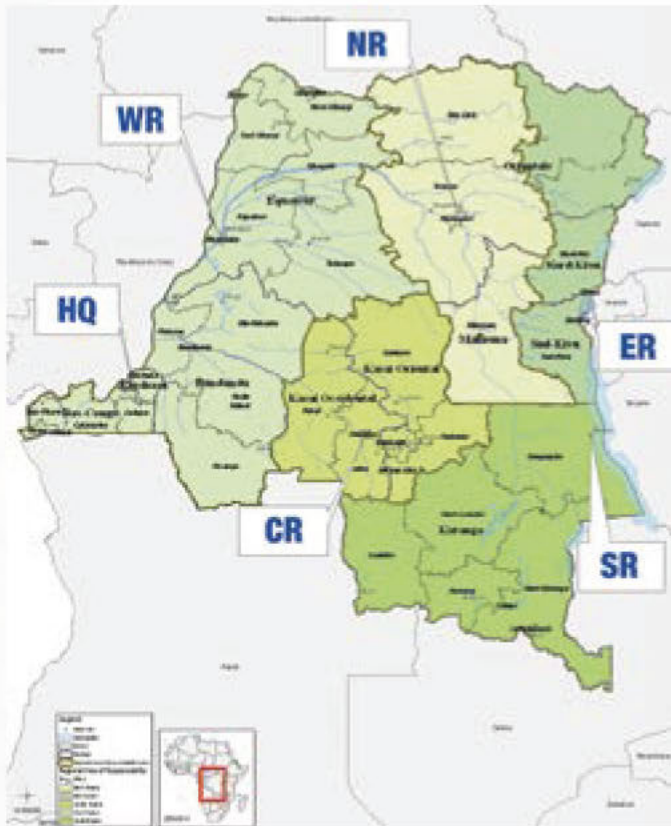


Figure 1. U.N. mine action activities in the DRC (2.3 million sq km [888,035 sq mi]) are managed by five regional offices and coordinated by the UNMAS-DRC headquarters in Kinshasa.

All figures courtesy of UNMACC.

2. Provide the confidence and assurance that mine action organizations adhere to standards in accordance with IMAS, national standards and their own standard operating procedures (SOP) throughout the conduct of operations for which they are accredited.¹
3. Secure a well-documented, effective and efficient QMS for all mine action activities in DRC, which can be implemented by national authorities.

Concurrently, an analysis was conducted in regional UNMAS-DRC offices (see Figure 1) to identify deficiencies and regional distinctions. The analysis was based on a survey questionnaire and informal talks between QA staff, the quality manager and the quality advisor over a two-month period. The result of the analysis led to five specific measures, which would be needed to meet the objectives of the QM policy:

1. Internal structures, processes and competencies need to be clarified and defined in standard working procedures (SWP) to create a uniform understanding of the functions and responsibilities of regional operational offices and to ensure that the application of QMS in daily operations is not dependent on the experience of individuals.²

2. All steps of the land release methodology in DRC must be subject to QM processes, and methodology must correspond with the latest international guidelines on land release.
3. A review and streamlining of accreditation, monitoring and post-clearance inspection processes is required to simplify and adapt the processes to the logistical constraints of working within DRC without compromising the integrity of the system.
4. An objective monitoring and evaluation tool must be developed and implemented to build on the continuous improvements of the system and its applications.
5. National standards are to be reviewed where relevant.

SOP and SWP

QM success relies on SOPs that unambiguously define each task, process and person's position within the program. The QMS must be used to link SOPs with relevant documentation and forms. For example, to issue a task, a task data sheet and task order must be generated and a task dossier opened. The SWP flow chart for opening a task dossier displays the step-by-step process and links each sub-procedure, document and form to the relevant step in the process. This is the backbone of the revised system. All SOPs are easily represented in a pictorial format through flow charts rather than through a set of written instructions and procedures, making them simple and helpful.

SWPs, together with the terms of reference for each position, also offer clear performance indicators that could be used to monitor and evaluate compliance by personnel as well as the effectiveness of the system.

Priority was given to developing and implementing SWPs at the operational level, specifically at UNMAS-DRC's five regional operational offices. Using a combined planning matrix based on the type of task, resource availability and access, SWPs for regional operational offices include the integrated planning of operations and QM, combining the monitoring of operations through both external and internal QA visits.

QA field visits are a shared responsibility for UNMAS and implementing partners. The visits are divided into multiple parts: Team leaders and site supervisors conduct self-assessments to evaluate the areas for which they were responsible, implementing partners' QM officers conduct internal assessments and UNMAS regional operational offices conduct external assessments. The records of the assessments as well as corrective and preventive actions are managed by UNMAS through mandatory weekly and monthly reporting and the inspection of site documentation. The reports are reviewed

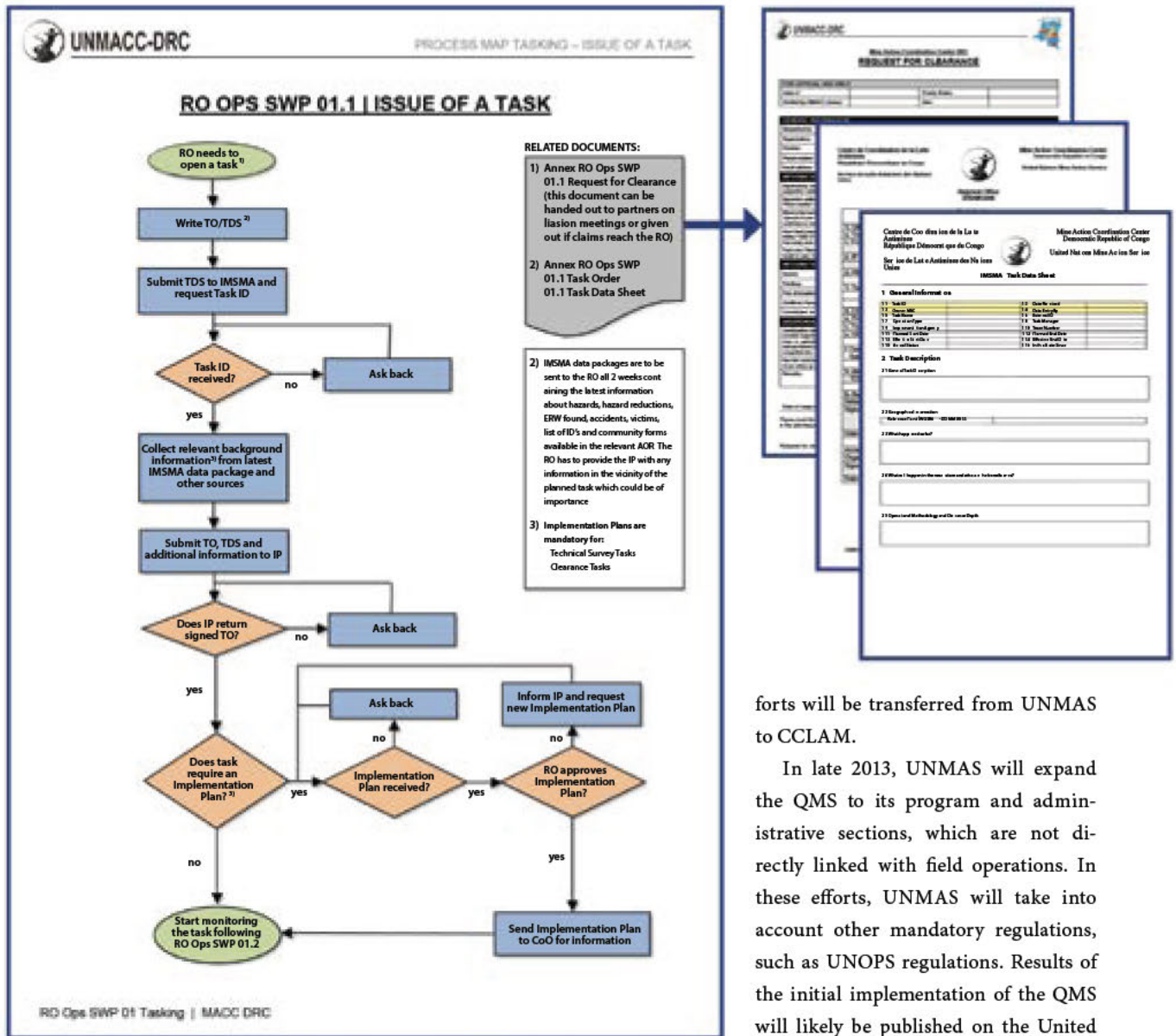


Figure 2. One example of a SWP for regional UNMAS-DRC offices. The process for issuing a task is shown in a digital flow chart and linked with the needed templates.

by the regional offices for completeness and correctness before being forwarded to UNMAS-DRC headquarters in Kinshasa (the base of the BSC system).

Regardless of the work conducted (survey, clearance, demolition or risk education), the increase in site-level quality assessments results in increased confidence. This is especially true for post-clearance inspections, which reduce the amount of land that must be sampled.

In July 2013, all UNMAS-DRC regional offices were issued the QMS, QA staff underwent training, and all SWPs were explained. Currently (August 2013–February 2014), six staff members from CCLAM are working in three regional offices and are undergoing training to learn the QMS and to build their capacity in managing the tasking, coordination and monitoring of mine action activities. Eventually, the responsibility for the QMS and other mine action ef-

orts will be transferred from UNMAS to CCLAM.

In late 2013, UNMAS will expand the QMS to its program and administrative sections, which are not directly linked with field operations. In these efforts, UNMAS will take into account other mandatory regulations, such as UNOPS regulations. Results of the initial implementation of the QMS will likely be published on the United Nations Mine Action Coordination Centre's (UNMACC) website and in UNMACC monthly updates, once adequate data is collected.

The Circle

Continuous improvement inherently means change. To ensure positive change, quality must be measured. QM is therefore heavily reliant on an objective, adequate monitoring and evaluation tool, such as the BSC system. The UNMAS program intends to use this method to examine the performance of the organizations it coordinates as well as to monitor its own performance and

adherence to QMS. Both UNMAS-DRC and the different UNMAS sections' performance are reviewed quarterly, and root-cause analysis is conducted to identify necessary corrective actions that will improve performance or the QMS itself.

Thanks to the contribution from the EOD Centre of the Swiss Armed Forces, the end result of the development of a QM policy is a commitment of all stakeholders (CCLAM, EOD Centre of the Swiss Armed Forces, UNMAS and national and international mine action partners in the DRC) to the continuous improvement concept, making the QMS in mine action an asset rather than a burden. ©

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Pascal Simon is the program manager at UNMAS-DRC. A mine action and capacity development specialist with extensive professional experience, he previously worked in Cambodia, Laos, Senegal and Tajikistan, supporting efforts to develop and reform mine action programs and related institutions. He holds a master's degree in political sciences and international relations from the *Université catholique de Louvain* (Catholic University of Louvain) in Belgium, and he also studied journalism and pedagogy.

Pascal Simon
Programme Manager
UNMAS-DRC
Kinshasa, DR Congo
Tel: +243 818 905 301
Email: psimon@macc-drc.org
Website: www.macc-drc.org



Stefan De Coninck has been working in mine action for over 20 years in various countries in Africa, Europe, the Middle East, and Southeast Asia. He has explosive ordnance disposal level four certification and has completed the International Register of Certificated Auditors' training for lead auditors.

Stefan De Coninck
Operations and Quality
Management Officer
UNMAS-DRC
Kinshasa, DR Congo
Tel: +243 81 890 5301 Ext: (175) 5301
Website: www.macc-drc.org

News Brief

Typhoon Haiyan Leaves Ordnance Contamination in its Wake

On 8 November 2013, Typhoon Haiyan, a category 5 super typhoon, landed in the Philippines causing widespread destruction. According to the U.S. Agency for International Development, 16 million people have been affected, with 6,155 confirmed deaths and 4.1 million people displaced.¹

During the typhoon, a military armory was destroyed near Tacloban, one of the cities most affected by Typhoon Haiyan. With 273.6-kmh (170-mph) winds and 4.572-m (15-foot) wave surges, Typhoon Haiyan scattered explosive remnants of war (ERW) throughout the surrounding area.^{2,3}

The Philippines does not have an official ERW clearance program, and various government agencies, including the Armed Forces of the Philippines and local police, handle clearance operations.⁴

Natural disasters can spread ERW and landmine contamination while exacerbating the difficulties of current humanitarian clearance efforts. Mines relocated by floodwaters are particularly dangerous. Deminers are trained to clear land-



A young resident of Tacloban City walks through debris left behind by Typhoon Haiyan.

Photo courtesy of U.N./Evan Schneider.

mines placed upright; however, floodwaters can cause landmines to sink into the mud in any position.⁵

The Philippine army is attempting to keep people away from contaminated areas, but locating the ordnance is difficult because many of the explosives, ordnance and grenades are covered by mud. ©

~ Brenna Feigleson, CISR Staff

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Survivors' Assistance in Conflict: Challenges From Eastern DRC

Because of the ongoing conflict in eastern Democratic Republic of the Congo (DRC), providing aid and rehabilitation assistance to survivors of mine-related injuries is difficult. Beyond essential rehabilitation services, the United Nations Mine Action Service's victim assistance efforts in DRC aim to provide economic skills to promote self-reliance and enable survivors to provide for their families.

by Douglas Felix Kilama [United Nations Mine Action Service]

In post-conflict contexts, mine action priorities alternate between humanitarian assistance, stabilization, reconstruction and development. In Democratic Republic of the Congo (DRC), the renewed conflict in the country's eastern region interrupted victim assistance efforts, halting and even reversing economic-reintegration projects. As a long-term objective, economic reintegration aims to provide alternative sources of income to enable survivors to become self-reliant; related efforts may include providing access to land and other production resources, microfinancing, public employment and vocational training. Such programs require a degree of developmental stability in order to succeed, and eastern DRC currently lacks stability.

However, reintegration programming addresses survivors' immediate needs, including immediate medical care after mine or explosive remnants of war (ERW) accidents, provision of non-food relief items to survivors and their families, and introductory vocational training on topics including animal and crop husbandry, catering, hair dressing, small-scale business management and tailoring. The benefits of UNMAS' economic-reintegration programs in DRC were examined over the last 12 months, focusing on the conflict-affected eastern region. As a

result of the programs, survivors became self-reliant, able to meet their economic needs and afford basic necessities such as food, school fees and clothing for their families.

Challenges

Eastern DRC presents distinct challenges for survivors and assistance providers. Poor physical infrastructure and ongoing conflict reduce access to services and hinder organizations from accessing remote areas where the majority of vulnerable survivors live. For instance, as a result of the recent conflict, survivors who moved into communities in the Rutshuru and Masisi territories of North Kivu lost their sources of livelihood and were forced to start new lives as internally displaced persons (IDP). Their income-generating activities ceased to enable financial independence, and they had to learn to live on relief items provided by humanitarian agencies.

Documented by the Information Management System for Mine Action, the majority of mine/ERW victims reside in eastern DRC (44 percent), totaling 2,514 survivors (606 female and 1,908 male).^{1,2} Factors that explain such a large disproportion of male to female survivor rates include various social and gender roles in the DRC. Men are more involved in work that requires significant movement like farming, fishing,

~ SUCCESS STORIES ~

Gedeon Ngoy, a 41-year-old father of five, was a beneficiary of UNMAS' economic reinsertion program in 2012. He can now pay school fees for each of his five children and bought a plot of land in Kisangani, DRC, to build a permanent residence and establish a farm for his family.

Stefan Piame, 65 years-old, testified that the small-scale business management training and the reinsertion kits were vital for his family: "I started up a business that enables me to earn on average US\$45 a day, feed my family of 10 and pay school tuition for my five children."

Gedeon and Stefan were successful because they started small businesses in kiosks with the reinsertion kits. They were also given kits with high-demand items in their communities, such as salt packets, bars and tablets of washing and bathing soap, gallons of cooking oil, bags of sugar, biscuits, lotion packets, and other basic items to start up retail businesses. They subsequently restocked the items using the profits earned from their businesses.

hunting and transporting goods to markets. These activities expose them to more landmine and ERW threats than women who typically work at home.

Relatedly, a “macho culture” exists where men look to prove themselves in the face of danger. They are the first to check potentially hazardous areas to ascertain if a place is safe or not, thereby increasing their exposure to potential threats. Finally, ex-combatants are more prone to complacent behavior when handling and manipulating dangerous objects as they believe they are capable of handling these weapons due to seeing and using them in combat.

Survivors require a disproportionately high amount of financial and medical resources for rehabilitation, and yet the majority are from rural areas without advanced medical infrastructure and with limited resources. While studies show that 25 percent of the world’s landmine survivors receive appropriate care, only 9 percent are estimated to receive assistance in eastern DRC.^{3,4}

UNMAS’ Programs

Since 2009, the United Nations Mine Action Service in DRC (UNMAS-DRC) has provided vital assistance to survivors with its partners—including organizations focusing on disabled people and local and international nongovernmental organizations (NGO).⁵

The Japanese and Australian governments fund the majority of UNMAS’ victim-assistance programs in DRC. An estimated US\$550,000 was used to assist 272 mine/ERW survivors (85 female and 187 male) and 12 other persons with disabilities in the past two years in DRC. The grants supported physical rehabilitation and economic reinsertion (including mine risk education), a national landmine-contamination survey and ERW/mine clearance. Heri Kuetu and Shirika La Umoja rehabilitation centers also received support to provide medical care and physical rehabilitation, and provided a range of mobility aids, including prostheses and other assistive devices, to the selected survivors.

Selected beneficiaries were trained in income-generating activities and were provided with reinsertion kits comprised of in-kind, start-up capital to enable small trade in marketable



Itongwa Wilonja tries his newly acquired bike at Shirika La Umoja rehabilitation center in Goma, DRC (June 2013).

Photo courtesy of Syahava Kambale Sylvain/Shirika La Umoja.

items in their areas. The training period varied between one and three months, depending on the Income Generating Activities (IGA) chosen by the survivors. The basic training in small-scale business management took about five days, while other vocations like tailoring took at least three months. Each UNMAS-DRC partner organization used subgrants to hire trainers to provide the training in the relevant operational areas. Trainers had experience in microfinance, livelihood and socioeconomic sectors.

In 2013 UNMAS granted US\$150,000 to help national organizations assist 207 survivors (63 females and 144 males). The average cost of assistance per survivor is around \$1,500, a necessary investment toward ensuring change in the lives of survivors and their families. The investment is comparatively high because UNMAS-DRC aims to make beneficiaries financially independent. The survivors are involved in all steps of the project to promote ownership and sustainability. Priority is given to feasible and sustainable projects. In addition to



A survivor chats with visitors at her kiosk in eastern DRC.
Photo courtesy of Micheline Yaisimba.

vocational skills, training also focuses on product packaging and marketing, as well as financial planning.

Obtaining sufficient funding to implement quality programming for all survivors is a key challenge. Within the scope of worldwide humanitarian mine action, landmine survivor assistance receives only 5 percent of all funding in the sector, and it receives even less in DRC. Since its founding in 2009, the UNMAS-DRC survivor assistance section received approximately 3 percent of the total program funding.⁶

Prospects

Organizations providing survivor assistance in DRC include the International Committee of the Red Cross, Handicap International (HI), Christian Blind Mission, the Ministry of Health, and the Ministry of Social Affairs, Humanitarian Action as well as organizations focusing on the disabled and several local NGOs coordinated by UNMAS-DRC.

Interventions are prioritized based on needs, taking into account gender and age when selecting beneficiaries for survivor assistance. Organizations are encouraged to involve survivors in planning, implementing and monitoring project activities.

Some NGOs recruited survivors to implement project activities, and they attest that these survivors were very instrumental to the success of the projects. Micheline Yaisimba, project coordinator of *Afrique Pour la Lutte Antimines* (Africa for Mine Action or AFRILAM), attributes this success to “survivors being able to identify with the project and also owning it,”⁷ as illustrated through the work of one of its employees, Rigobert Wakengela, a 38-year-old landmine survivor who plays a vital role in the organization’s project implementation. He is a social worker who engages in mobilization and counseling of disabled persons as well as conducts risk-education sessions in affected communities.

To ensure quality standards, UNMAS and the *Centre Congolais de Lutte Antimines* (Congolese Mine Action Center or CCLAM) developed the 2012 National Standards for Victim Assistance.⁸ By the end of 2014, all survivor assistance organizations will be accredited using the 2012 Victim Assistance National Standards in DRC, which emphasizes assistance based on the *Guiding Principles for Victim Assistance*, compiled by the Working Group on Victim Assistance of the International Campaign to Ban Landmines.⁹



Furaha Dico lost both legs in a mine accident in Bunia in 2007. Furaha chose to be trained in tailoring by *Premiere Alerte* (UNMAS-DRC partner organization). Photo courtesy of Philippe Ebimba/UNMAS-DRC.

In an effort to accomplish their obligations, UNMAS and CCLAM developed the Transition Plan 2012–2014 and Strategic Plan 2012–2016, which are the benchmarks for mine action activities. Section 6.4.4 of the strategic plan explicitly illustrates survivor assistance.¹⁰

In terms of advocacy, UNMAS, HI, the Ministry of Health, the Ministry of Social Affairs, Humanitarian Action, Christian Blind Mission, Congolese Campaign to Ban Landmines and other national NGOs working with disabled persons formed a working group advocating for the ratification of the *Convention on the Rights of*

Persons with Disabilities (CRPD) and the adoption of a law for its implementation in DRC.^{11,12} Consequently, DRC’s parliament adopted a law on CRPD ratification 29 May 2013.

The U.N. underlines the importance of integrating the needs of landmine and ERW survivors in national policies and programs that address the needs of all disabled people. UNMAS also emphasizes activities that promote and comply with relevant international humanitarian and human rights standards.¹³ In DRC, due to the challenges posed by the country’s size and poor logistical

situation, UNMAS-DRC aims to demonstrate that an effective approach, involving sufficient funding and close supervision, can achieve concrete and long-lasting results, even in the complicated context of eastern DRC.

Additional challenges remain such as dwindling funding in the mine action sector, gaps in DRC’s national capacity to address victim assistance and disability-related issues, as well as poor physical and service infrastructure. The National Mine Action Strategic Plan 2012–2016 makes national capacity building, along with transition and resource mobilization, priority strategies to address these challenges. ©

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Douglas Felix Kilama is the victim assistance specialist with the United Nations Mine Action Coordination Centre in DRC. He graduated with a master’s degree in diplomacy and international studies from Uganda Martyrs University (Uganda) and has been working in victim assistance and mine risk education for 11 years in Angola, Somalia, Sudan and Uganda with Canadian Physicians for Aid & Relief, DanChurchAid, Danish Demining Group, Handicap International and MAG (Mines Advisory Group).

Douglas Felix Kilama
Victim Assistance Specialist
United Nations Mine Action
Coordination Centre – DRC
34 Avenue Pumbu,
Commune de la Gombe
B.P. 16.696 Kinshasa / DR Congo
Tel: +243 825001827
Email: dkilama@macc-drc.org
Website: http://macc-drc.org

News Brief

Mercer University Professor Provides Prostheses in Vietnam

According to the U.S. Department of State, innumerable explosive remnants of war (ERW) and landmines remain hidden in nearly every region of Vietnam.¹ The Vietnamese government approximates that 15 percent of the total surface area of Vietnam retains unexploded ordnance (UXO) contamination.² The *Landmine and Cluster Munition Monitor* reported 73 mine/ERW casualties in Vietnam in 2012 (53 injured/18 killed/2 unknown).³ Moreover, there are over 100,000 amputees currently living in Vietnam and many find it difficult to afford decent prostheses.⁴

Dr. Ha Van Vo, medical doctor and professor in the biomedical engineering department at Mercer University in Georgia (U.S.), has provided nearly 1,000 Vietnamese with prosthetic legs.¹ As a native of Vietnam, Vo witnessed firsthand the devastating injuries caused by landmines in postwar Vietnam.

"I remembered my people in Vietnam with no legs, crawling. Children—a lot of them," he said, "I said, 'Oh, we have to do something for them. They cannot just crawl in the dust like that.'"⁵

Manufactured in the Mercer University laboratory, Vo designed a prosthesis with three components: a socket, a pylon that serves as a leg bone and a foot.⁵ The innovative design features a "V-cut" in the back, allowing the patient to adjust the size of the socket opening as the size and shape of their stump changes. This is a paramount feature, as a standard prosthesis generally needs to be replaced every two to three years, which is difficult for many people in Vietnam who cannot afford to replace them.¹ The prosthetic sockets made in the Mercer University laboratory are cheaper to produce because they are made of polypropylene plastic instead of carbon fiber.⁵



Dr. Ha Van Vo fits a prosthesis on a patient in Vietnam.
Photo courtesy of Mercer University/Burgess Brown.

At a cost of only US \$120 per prosthesis to manufacture, coupled with enough grants and donations to cover material costs, Vo is able to provide prostheses to Vietnamese amputees free of charge.^{5,6} Since 2009, Vo has taken faculty and student volunteers from Mercer University to Ho Chi Minh City, Can Tho and Phung Hiep numerous times, bringing with them hundreds of these prostheses.⁵ Vo and volunteers quickly custom-fit each prosthesis by molding the thin plastic with heat.¹

In 2012, Mercer partnered with *Caritas Internationalis*, a local organization in Ho Chi Minh City, to manufacture Vo's design in Vietnam.⁶ The partnership raised custom fittings in Vietnam from hundreds per year to thousands per year.¹

There are over 18 million amputees in the world, of which 80 percent reside in developing countries.⁴ Vo hopes to expand his program to Africa, the Middle East and the U.S. in coming years.¹ ©

~ Erica Qualliotine, CISR staff
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RESEARCH & DEVELOPMENT

Research and Development Section Sponsored by



Machine-integrated Magnetic Collector Design and Testing

The Geneva International Centre for Humanitarian Demining led a test program to evaluate a machine-integrated magnetic collection system. Promising results suggest it could speed up manual follow-up activities and provide valuable data during technical survey operations.

by Erik de Brun [GICHD Consultant] and Stephen Ahnert [GICHD Consultant]

In 2011 and 2012, the Geneva International Centre for Humanitarian Demining (GICHD) led a test program to evaluate the feasibility and effectiveness of a mechanical demining, machine-integrated magnetic collector designed to collect ferrous metal debris during flailing operations. The purposes of this integration and test effort were to determine if

- A machine-integrated magnet would collect metal debris during flailing operations
- A machine-integrated magnet would increase the efficiency of demining operations by speeding up manual follow-up (especially when working in an area with high metal contamination)
- Collected debris could be utilized to support technical survey operations

Together, the GICHD and DOK-ING designed a magnetic collection system and integrated it with an MV-4 flail. In March 2012, the authors, along with other team members from the Swedish Explosive Ordnance Disposal and Demining Center (SWEDEC) and DOK-ING, conducted functional and statistical testing in Zagreb, Croatia. During functional testing, the setup and configuration of the magnetic collection system was optimized and subsequently utilized for statistical testing. The statistical testing results were very promising, with 44% (240 of 544) of the seeded ferrous debris recovered during the first pass of the machine and 34% (102 of 304) of the remaining debris recovered on the second pass. In the end, 68% (371 of 544) of the seeded debris was collected. Although the testing was only conducted in one set of conditions and utilized seeded debris, the collection percentages are sufficiently high to suggest that a machine-integrated magnetic collector could dramatically reduce the amount of ferrous material remaining in the field following flailing operations. If results hold in field conditions, this methodology could dramatically speed up manual follow-up activities and provide valuable data during technical survey operations.

Introduction

Mechanical demining systems can greatly increase the effectiveness, safety and efficiency of mine-clearance operations. They clear or release large areas more quickly and safely than manual demining alone. In most cases, national standards require some form of manual follow-up after machine clearance, which can range from visual inspection to full manual clearance requiring the removal of all metal debris. When 100% metal-free clearance is required or when operating in areas heavily contaminated with ferrous material, follow-up manual clearance can be painstakingly slow because every metal detector indication must be investigated.

GICHD recognizes that, combined with mechanical tools or as stand-alone assets, magnets can increase manual clearance productivity by removing ferrous metal debris from the clearance area. In addition, the collection of metal debris can provide invaluable information about



Figure 1. DOK-ING MV-4 utilized during testing.
All graphics courtesy of the authors/GICHD.

the type and location of contamination during technical survey and clearance operations. Ideally, magnet-equipped machines would collect a large percentage of the metal contamination in a given area, increasing overall operational efficiency.

GICHD previously tested a combined flail and magnet system using a Bozena 5 that towed a permanent magnet. An operational assessment was conducted in Azerbaijan between January and March 2010. The towed magnet picked up some ferrous debris, and recovery effectiveness was very low overall. A full report on the testing can be obtained from GICHD.¹ Based on that testing's results, several improvements to the magnetic collector design and configuration were hypothesized, and DOK-ING was contracted to assist with design and construction of a revised magnetic collector that would be integrated directly with the machine flail head. This article documents the testing that GICHD conducted at DOK-ING's manufacturing facility in Zagreb, Croatia, in March 2012.

Materials and Location

The following testing equipment was used:

DOK-ING MV-4. Two separate MV-4 machines with flail attachments were utilized during testing.

Magnetic roller. A magnetic roller was one component of the magnetic collection system. Measuring 220 mm in diameter and 1,740 mm wide, it was installed directly behind the flail head (Figure 2, page 53). On each roller's side, teeth ensured that it rotated as the machine advanced. The roller height relative to the flail was adjustable. The roller contained



Figure 2. Magnetic roller attachment.



Figure 3. Magnetic sheet attachment.

242 neodymium permanent magnets (each 42 mm by 40 mm by 6 mm) spaced evenly, adhered directly to the base metal roller and covered with an abrasion-resistant rubber. Field strength of the magnets was 0.17 Tesla on the dorsal and ventral faces, and 0.34 Tesla on the lateral faces.

Magnetic sheet. Another component of the magnetic collection system was a magnetic sheet (Figure 3 above) that was mounted behind the flail head in place of the chain guard. The sheet was 1,740 mm wide by 500 mm tall with magnets present in the lower two-thirds. The sheet contained 175 neodymium magnets evenly spaced in a 5-by-35 grid covered with an abrasion-resistant rubber coating, yielding an overall field strength of 0.2 Tesla at the sheet surface.

Magnetic upper catch. In addition to the magnetic roller and sheet, a magnetic catch was installed along the front edge of the flail shroud, above the flail head (Figure 4 right). This upper catch was designed to capture magnetic debris thrown forward by the flail hammers. The magnetic catch was constructed similarly to the sheet but contained only a single row of magnets.

Ferrous debris. Various types of ferrous debris (Figure 5, page 54) were used to seed the test lane. The debris elements were selected to reflect the size and shape of ferrous debris that would typically be recovered during actual clearance operations. Table 1 (page 55) lists the different types of material used during the testing.

Testing was performed in a prepared lane at DOK-ING's main production facility in Zagreb. The test lane was approximately 45 m long, 4 m wide, 0.5 m deep and filled with relatively fine riverbed sand (Figure 6, page 54).



Figure 4. Magnetic upper catch attachment.

With the weather clear, temperatures ranged between 18 C and 22 C during the test period. The sand was dry throughout the tests and was not compacted beyond the compression provided by the MV-4 tracks. Rakes were used between tests to level the sand as necessary, and a bulldozer periodically leveled the lane.

Testing Procedures

The testing was divided into two separate phases: functional/experimental testing and statistical testing. During the functional tests, the

setup and configuration of the magnetic collection system was varied in order to identify the most effective arrangement. Each setup was tested using different seeding materials, flail rotational speeds, machine speeds and working depths in order to identify the effects of these variables on the effectiveness of the different configurations. Once the most effective configuration was identified, the focus shifted to statistical testing. The statistical testing focused on generating a consistent, statistically significant data set from which debris-recovery percentages could be estimated.

Functional tests. A number of functional tests were performed to evaluate and optimize the magnetic collection system's performance.

- Series 1: surface-laid debris recovery without the flail spinning
- Series 2, 4 and 6: magnetic-sheet evaluation and configuration optimization
- Series 3 and 5: magnetic-roller evaluation and configuration optimization
- Series 7: full magnetic collection system optimization (roller, sheet and upper catch)

Statistical tests. Based on the results of the functional testing, the following magnetic collection system and machine configuration (Figure 7, page 55) was used for all of the statistical tests:

- Magnetic sheet hanging immediately behind the roller with chains controlling the orientation
- Magnetic-sheet, upper-catch and magnetic-roller setup on same MV-4
- Machine-operating parameters set at a working depth of approximately 15 cm, a machine speed of approximately 1.5 km/h and a flail-head speed of approximately 450 rpm (50% of maximum)
- Roller placed in its lowest position (centerline of roller approximately 5 cm above the flail skids)

The test lane was divided into four boxes, each approximately 7 m long, with a gap of approximately 4 m between each area. Each box was

seeded with a specific set of ferrous debris (Table 2 page 55). With 68 seeded targets in each of the four test boxes, there was a total of 272 seeded items for each test. Within each test box, debris was randomly seeded within a strip approximately 1.5 meters wide in the test lane's center. The debris was buried to varying depths up to 15 cm. The statistical test was performed twice. During the first test, the seeded debris was painted green; during the second test, the seeded debris was painted yellow so that any remaining debris from the first test that was collected during the second test could be identified and excluded from the results.

After completing each box in the first test, the flail was removed so that captured debris could be removed and recorded. After completing the initial pass through the four test boxes, displaced soil was pushed back into the flail track with rakes. In order to see what percentage of the remaining debris each test box could recover, this process was repeated without any additional reseeded or manual clearance. A third pass was also performed without stopping after each box.

Before the second test, a hand-held metal detector and shovels were used to find and remove as much of the remaining debris as possible. This manual-collection effort reduced the amount of contamination for subsequent tests and identified the approximate depth of the debris not recovered by the magnets.

The second statistical test procedure was very similar to the first test except that four passes were performed. During the third and fourth passes, the flail path was shifted slightly to the right and left, respectively, in order to process areas where soil was pushed out to the sides during the first and second passes.

Results of Functional Tests

The functional testing's main purpose was investigating each component of the magnetic collection system and determining the optimal configuration for the system as a whole. Initial testing with surface-laid debris showed that the debris is easily captured yet cannot be easily dis-

lodged if it comes into contact with one of the magnetic collectors. Testing of the magnetic roller showed that collection was much more effective if the roller was set as low as possible (centerline of the roller was approximately 5 cm above the flail skids), allowing the roller to plow through the soil deposited just behind the flail head. As the machine advanced, the roller would push a large mound of soil ahead of it, causing flailed soil to be pushed back into the path of the upward-moving flail hammers. Forward soil ejection from the top of the flail shield increased dramatically compared to previous



Figure 5. Ferrous debris utilized during testing.



Figure 6. Test lane and close-up of soil.



Figure 7. Machine setup for statistical testing.

ID	Description	OD	ID	Thickness/ Length	Mass
1	Large Washer	28.0 mm	6.7 mm	2.0 mm	8.6 g
2	Medium Washer	20.0 mm	10.5 mm	2.0 mm	3.1 g
3	Small Washer	15.0 mm	3.0 mm	2.0 mm	2.6 g
4	Large Nail	3.4 mm		78.0 mm	5.7 g
5	Small Nail	2.8 mm		58.0 mm	3.1 g
6	Wire	3.0 mm		100–150 mm	7.5 g
7	Medium Slug	24.0 mm		15.0 mm	55 g
8	Small Slug	16.0 mm		15.0 mm	21 g
9	Large Slug	>30.0 mm		5–15 mm	36–382 g

Table 1. Characteristics of seeded ferrous debris.

tests, and a substantial amount of soil flowed over the top of the roller (Figure 8, page 56). As a result of the soil flow over the roller, the recovery percentage was dramatically higher than previous tests (30–50% recovery), and additional passes through the same test area continued recovering substantial debris.

The magnetic sheet alone was not very effective (capturing up to 20% of the debris), but the collection effectiveness was increased dramatically when placed just behind the roller due to the amount of soil contact. In addition to the magnetic collection system configurations, many operational variables, including fail speed and machine speed, were also investigated.

Based on testing, the optimal magnetic collection system configuration consisted of the magnetic roller placed in its lowest position, the magnetic sheet positioned directly behind the roller and the upper catch placed at the front of the flail shield (Figure 9, page 56). All subsequent statistical testing utilized this configuration.

Results of Statistical Tests

The optimized magnetic collection system configuration (Figure 10, page 56) utilized during the statistical testing proved quite effective. During the two combined statistical tests, 44% (240 of 544) of the seed-

ID	Description	Qty
1	Large Washer	12
2	Medium Washer	12
3	Small Washer	12
4	Large Nail	12
5	Small Nail	12
6	Wire	12
7	Medium Slug	6
8	Small Slug	2
Total		68

Table 2. Seeded debris in each test box (type and quantity).

ed debris was recovered on the first pass, and 34% (102 of 304) of the remaining debris was recovered on the second pass. The collection effectiveness decreased significantly to 8% (17 of 202) of the remaining debris for the third pass. Figure 11 (page 57) shows the percentage of available debris recovered during each pass, separated by debris type. In general, a similar debris percentage was recovered on each pass, regardless of debris type.

In addition to the quantity of each debris type, the recovery location (roller, sheet or catch) of the debris was also recorded and analyzed. Figure 12 (page 57) shows the breakdown of recovery location, separated by debris type. For the lighter types (washers, nails, wires),

the roller collected the majority of the debris (50% on the roller, 26% on the upper catch and 24% on the sheet). However, for the larger, heavier debris types (medium and small slugs), the percentages shifted dramatically with 34% collected on the roller, 65% on the upper catch and 2% on the sheet. One potential explanation for this difference is that a direct hit from one of the upward-swinging flail hammers could impart enough momentum to free a slug from the surrounding soil and send it to the upper catch, whereas the smaller debris types are less likely to encounter direct hits from the flail hammers and are slowed more dramatically by the surrounding soil due to their shape and smaller inertia.

In general, all three components of the statistical test configuration contributed significantly to the overall recovery effectiveness, which suggests that placing magnets in multiple locations around the flail head yields higher collection percentages.

Following the completion of the statistical testing, a purely qualitative test was performed in a topsoil area contaminated with ferrous material adjacent to an industrial warehouse and machine shop. A section approximately 2 m in length was flailed to a depth of 15 cm. As seen in Figure 13 (page 57), several handfuls of metal debris, ranging from small particles to large chunks, were collected. The result, while purely qualitative in nature, suggests that the configuration



Figure 8. Increased soil turbulence with magnetic roller in lowest position.



Figure 9. Optimal configuration of the magnetic collection system.



Figure 10. Statistical test run.

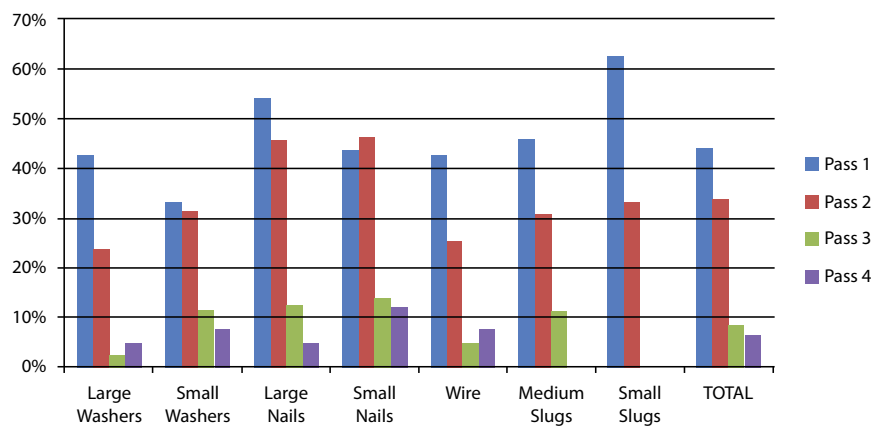


Figure 11. Percentage of remaining debris collected by pass.

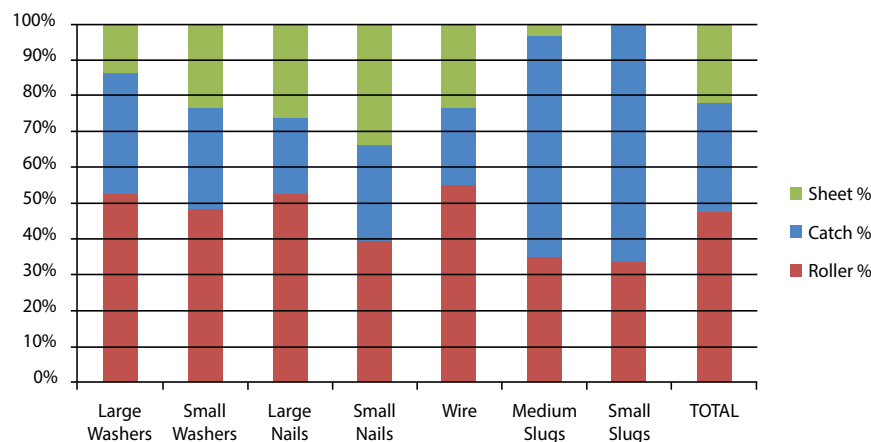


Figure 12. Location of breakdown of collected debris.



Figure 13. Qualitative topsoil test and collected debris.

may be effective in soil conditions other than dry, loose sand. It also shows that magnets are effective at capturing ferrous debris covered with substantial oxidation and other surface contamination conditions likely to be found in the field.

Discussion

The testing showed that machine-integrated permanent magnets can be effective in collecting ferrous debris (during testing, more than 40% of seeded debris was collected on the first pass). Although the testing was conducted in dry, loose sand using seeded debris, the collection per-

centages are sufficiently high to suggest that machine-integrated magnets could dramatically reduce the amount of ferrous material remaining in the field following flailing operations. Reducing the number of metal-detector indications during manual follow-up can significantly increase deminer speed, which improves the overall efficiency of clearance operations. The results also suggest that machine-integrated magnets can provide beneficial data on minefield contamination when used during technical survey operations.

Soil/magnet contact. The testing showed that the action of the flail hammers tended to deposit metal debris in the loose soil behind the flail and the majority of the debris remained below the surface of the flailed soil. Since permanent magnets do not typically have sufficient strength to pull material through a substantial amount of soil, magnetic configurations passing over the top of the loose soil recover only a small fraction of the debris. Because of this, magnetic collectors pulled behind machines have very low effectiveness. In order to increase collection effectiveness, raising the percentage of the soil that comes into direct contact with the magnetic surface is necessary. With the magnet geometries available during this test period, the most effective method involved placing the roller in its lowest position. The resulting configuration caused soil to flow over the roller and dramatically increased the amount of soil thrown up toward the sheet and the upper catch, which substantially raised the percentage of soil and debris that came into direct contact with the magnetic surfaces.

Debris removal. Once the debris adhered to the magnets, removal was relatively time-consuming. The magnets did not include any provision for wholesale removal of the debris, so pieces were removed individually by hand. While this was acceptable for testing, during actual clearance operations in heavily contaminated areas, metal debris accumulation may be so rapid that the magnets must be cleared at frequent intervals to the point where area processing speed would be adversely affected by time-consuming debris removal.

Conclusion

The results of the testing suggest that machine-integrated permanent magnets can be effective at capturing ferrous debris during flailing operations. However, after observing the movement of the debris-filled soil during testing, the test configuration could clearly be further optimized to improve debris collection. The flail shroud could be designed to efficiently guide the soil deposited behind the flail head to the magnetic collection area. A ramped surface immediately behind the flail head (in place of the roller) would allow soil to be thrown upward and funneled into channels, maximizing its exposure to magnetic surfaces. A larger upper catch would further improve collection effectiveness. In addi-

tion, any integrated magnetic collector must include provisions to easily clear debris from the collection surfaces.

Once the magnetic collection system is redesigned, additional testing in a controlled environment (such as SWEDEC) and a representative field environment (such as an actual minefield or known battle area) is recommended. The focus for these tests should be

- To determine what impact ferrous debris collection has on the efficiency of manual follow-up clearance
- To determine what impact ferrous debris collection has on technical survey operations
- To develop operational procedures for working with a machine-integrated magnetic collector

With additional input from field testing, machine-integrated magnetic debris collection could dramatically speed up manual follow-up activities and provide valuable data during technical survey operations. ©

See endnotes page 67



Erik de Brun is a partner and co-founder of Ripple Design. He is involved in the design, development, testing, and manufacturing of mechanical demining equipment as well as the management of demining operations. Prior to founding Ripple Design, de Brun designed and tested armored vehicles with BAE Systems and V-22 Osprey flight-control software with Boeing Rotorcraft. He holds a Master of Science in mechanical engineering and applied mechanics from the University of Pennsylvania (U.S.) and a Bachelor of Science in mechanical and aerospace engineering from Princeton University (U.S.).

Erik de Brun
Principal Engineer & Partner
Ripple Design (GICHD Consultant)
444 North 4th St., Suite 102
Philadelphia, PA 19123 / USA
Tel: +1 267 872 5768
Email: erik.debrun@rippledesign.com
Website: http://www.rippledesign.com



Stephen Ahnert is a partner and co-founder of Ripple Design. He has extensive experience in mechanical design and analysis spanning a variety of different industries, including demining and commercial nuclear power. Prior to founding Ripple Design, Ahnert designed and tested products for high volume manufacturing and worked in the nuclear power industry performing combine thermal-structural analysis and tool design. He holds a Bachelor of Science in mechanical engineering from Princeton University (U.S.).

Stephen Ahnert
Principal Engineer & Partner
Ripple Design (GICHD Consultant)
Tel: +1 703 309 9117
Email: stephen.ahnert@rippledesign.com



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A Discrimination Method for Landmines and Metal Fragments Using Metal Detectors

While discrimination methods for distinguishing between real mines and metal fragments would greatly increase the efficiency of demining operations, no practical solution has been implemented yet. A potentially efficient method for the discrimination of metallic targets using metal detectors uses a high-precision robotic manipulator to scan the minefield. Further field research is needed, however, before this method can deploy for operational use.

by Alex M. Kaneko, Edwardo F. Fukushima and Gen Endo [Tokyo Institute of Technology]

Current detection and clearance methods suffer from high false-alarm rates (FAR) and are costly, dangerous and time consuming. In 2001, the Tokyo Institute of Technology began work on a semi-autonomous mobile robot, the Gryphon (Figure 1), to facilitate the mine-detection process.¹ The robot's manipulator is equipped with tools for cutting vegetation and uses mine sensors to scan rough terrain, record data and note suspect locations by marking the ground. During experiments in test fields of flat terrain with no vegetation, the Gryphon proved as efficient as human operators when using a mine detector based on electromagnetic induction, such as a metal mine detector (MMD).² The Gryphon proved superior when compared to human operators in terms of reducing FAR and increasing probability of detection. However, similar to other demining solutions, FAR is still problematic with the Gryphon.

Problem Statement

One of the greatest problems in manual humanitarian landmine detection and removal involves high FAR, which are inherent to the use of electromagnetic induction-based detectors. Currently, no commercially available MMDs can distinguish landmines from other metal fragments. Some electromagnetic induction-based detectors, however, can select metal types to be searched, such as gold detectors.³ Similarly, MMDs can be used for the discrimination of landmines and other metal fragments, as shown by research in the following topics:

1. Algorithms for evaluation of detected signals using models of physical phenomena^{4,5,6}
2. Feature extraction from MMD signals and classification of data according to metal type, size or depth of the metal fragments^{7,8,9}
3. Algorithms that combine time domain analysis and frequency domain analysis^{10,11}

Some methods also rely on a dual-sensor approach, which combines two sensors and an MMD with ground-penetrating radar (GPR).^{12,13} However, a high level of expertise is still needed to properly evaluate the obtained data (image or sound). Moreover, discrimination has a large safety margin, which keeps FAR high. Another interesting method that has been reported uses image processing, MMD-signal surface area and volume calculation to estimate size and material, followed by depth estimation, which is achieved by placing the MMD at different angles.⁹ Despite reducing FAR to 39%, this method requires too much additional information from several depths (layers) besides the standard scan for discrimination, which considerably slows the demining operation by many minutes.⁸

Unfortunately, these methods have yet to be successfully implemented for use in practical demining tasks. Here, preliminary research on a potentially faster, newer, more accurate, on-site method (no need for additional scans) for discrimination of metallic targets using metal detectors is presented, and takes advantage of high-precision scans of the minefield using a robotic manipulator as shown in Figure 1.

Robotic Scanning and Sensor Data

The usual scanning procedure consists of manually swinging the MMD sideways while advancing the search head in increments between one scan and another. A robotic arm, which achieves higher precision and repeatability, can conduct a similar procedure. For a human deminer, the MMD signals (called V[%] here) are transformed into sound, and the deminer must remember and search the position of the ground target. For a robotic system, the sensor signal can be transmitted to a

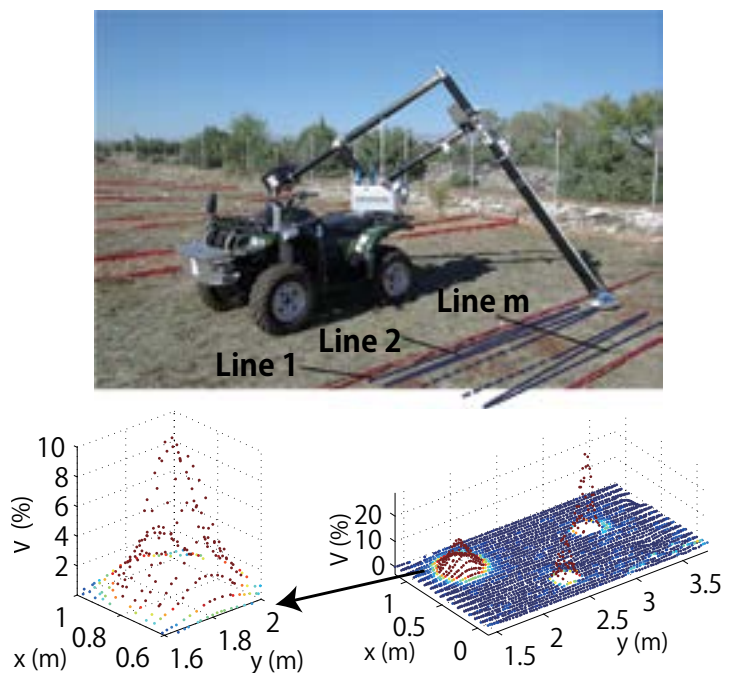


Figure 1. The demining robot Gryphon and its metal mine-detector signal visualization.

All figures courtesy of the authors.

computer and easily associated with the location of the manipulator. The signal can be processed in real time, and the user can easily visualize it (Figure 1). For the Gryphon system, the target position can be marked directly on the ground by painting or placing colored markers on the spot.¹⁴

SRMMDS uniqueness. Figure 2 shows a 3-D plot of the MMD signal, also known as a spatially represented metal mine-detector signal (SRMMDS). SRMMDS drastically changes according to postures and target types. Depending on the target, SRMMDS will present different characteristics, which can include physical properties such as depth, material, posture, shape, size and soil conditions. This implies that if a database of SRMMDS for every target in every condition could be rebuilt, one would only need to compare the SRMMDS obtained in the minefield to get the closest match in the database, which would identify the target, as well as the target's depth and posture. Even though some metal detectors can discriminate metal types, this feature is explored differently in this research.³ Different metal types generate positive or negative SRMMDS, suggesting the type of metal. However, the combined characteristics that compose the detected SRMMDS are fundamental for identification in this research, features such as the depth, material, posture, shape, size and soil conditions. Although previous works used databases, this research has a different approach in which a high-precision robotic arm obtains SRMMDS. Simplified, only the necessary parts of the whole SRMMDS are stored in the database using simple yet powerful mathematical relations.^{7,8}

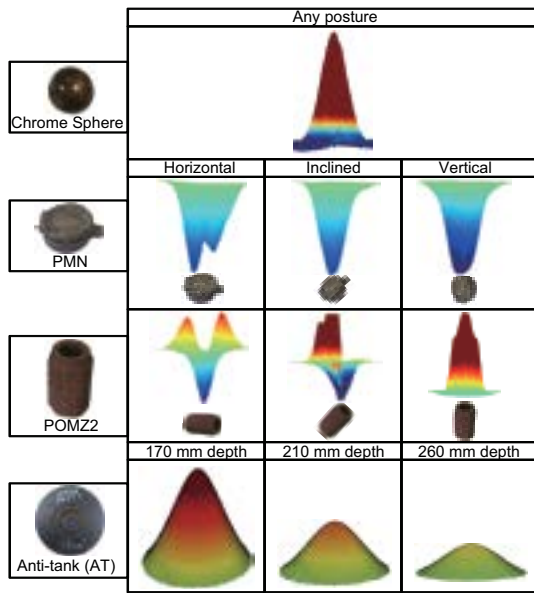


Figure 2. SRMMDS for different targets at different postures and depths.

SRMMDS simplification. In Figure 3, θ is defined as $x'y'z'$, the local coordinate for SRMMDS. While the $x'y'$ plane parallels the MMD scanning plane, the z' -axis passes through the maximum absolute point of the SRMMDS. The plane $P\theta$ is orthogonal to the $x'y'$ plane and passes through the z' -axis at an angle θ relative to the x' -axis. The intersection of plane $P\theta$ and the SRMMDS contour generates a new curve, which is a characteristic curve known as $V(r(\theta))$ (Figure 3) that is referenced to the new axis $r(\theta)$ and defined by the intersection of planes $P\theta$ and $x'y'$.

Figure 3 demonstrates that the characteristic curves of physically symmetric targets such as anti-tank (AT) mines are the same for any angle θ , while curves for nonsymmetric targets change drastically. This analysis suggests that SRMMDS can be simplified to a set with a minimum number of characteristic curves. For symmetric cases, one characteristic curve would be enough, but this is not obvious for nonsymmetric cases. For the nonsymmetric targets (shown in Figure 2), a characteristic curve for the target's longest length of direction presents many inflec-

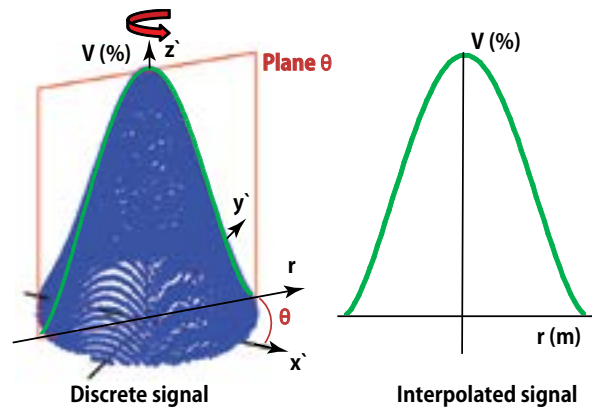


Figure 3. Cutting plane using as example the obtained signal of an anti-tank mine.

tions and peaks when compared to other angles. This research defines the characteristic curve with most inflections and peaks as the **main characteristic curve** and its axis $r(\theta)$ as the **main axis**. Figure 4 shows some examples of main characteristic curves.

Polynomial Characterization

Characteristic curves can be represented by splines, polynomials or other mathematical relations in the form of $V = f(r(\theta))$. As the number of inflections for the characteristic curves is limited, the authors propose polynomials in the form of Equation 1. This method has the advantage of keeping the signal characteristics and filtering part of the noisy raw data at the same time. In this work, all signals are translated with maximum peak in $r = 0$, making a_0 the maximum absolute MMD value of the signal.

Equation 1: $f(Y) = a_0r(\theta)^0 + a_1r(\theta)^1 + a_2r(\theta)^2 + \dots + a_n r(\theta)^n$
 Where $a_0, a_1, a_2, \dots, a^n$ are polynomial coefficients

In this research, the integral of the polynomials' difference (Equation 2) is adopted as the measure of error (Err [%])—i.e., similarity—between characteristic curves, which will serve as the main criteria for discrimination.

Equation 2: $Err = \int |f - g|/h * 100$
 Where f and g are polynomials to be compared
 $h = \max[\int |f|, \int |g|]$

Basic Discrimination Scheme

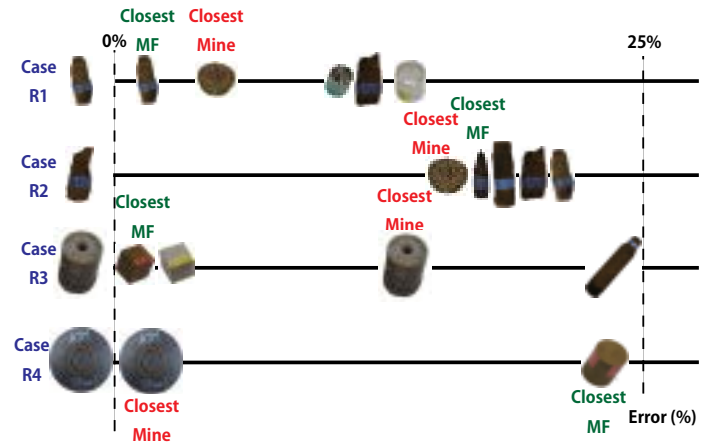


Figure 4. Examples of main characteristic curves with different peaks, intensities and sizes.

The basic scheme for discrimination of sensed signals can be implemented as follows:

- **Step 1:** Calculate the *Err* (Equation 2) for the characteristic curve of the sensed signal against all data in the prebuilt database.
- **Step 2:** Select the data with minimum *Err* as candidate for discrimination.

This scheme can result in four possible cases, namely R1, R2, R3 or R4, as shown in Table 1(a) and illustrated in Figure 5. Cases R1 and R4 result in correct discrimination. Although R2 results in a false positive and thus increases FAR, it is still acceptable. However, case R3 finds metal fragment data as the closest match for a landmine-obtained signal, causing a false negative result (mine judged as a metal fragment), which is unacceptable in this or any other demining research.

In this research, a false negative can be overcome by flagging as potential mines all metal fragment data that can cause case R3, resulting in a new case R3', as shown in Table 1(b). The identification of R3 and the R3' flagging are conducted during the database building and conditioning process, as explained in the database section.

Practical Discrimination Process

Measure of difference of errors (dE). In Figure 5, the *Err* of some metal fragment data is close to mines, as in the R1 example. To prevent any misjudgments in a real situation, Equation 3 calculates a measure of difference of errors (*dE*), which is the difference between the *Err* of the closest metal fragment (*Err*(closest MF)) and the *Err* of the closest landmine (*Err*(closest landmine)).

Equation 3: $dE = Err(\text{closest MF}) - Err(\text{closest landmine})$

A threshold for *dE*, *dE*_{threshold}, is also defined for flagging all metal fragments in which $|dE| < dE_{\text{threshold}}$ as potential mines, thereby reducing the chance that landmines are discriminated as metal fragments.

Measure of confidence (E_{threshold}). Another case that can be observed in Figure 5 involves the *Err* of the closest target (called *E*_{closest}) that sometimes can be too high, which indicates no matches in the database. This can mean that the data contains too much noise or the target is degraded, making it a potential risk. In this research, a safety criterion labels the test subject as a potential mine when *E*_{closest} is greater than a given threshold, *E*_{threshold}, to be determined by experiments. Figure 6 shows some examples of metal fragments similar to landmines.

Discrimination steps. The final scheme for discriminating sensed signals, while taking into account the above measures, is implemented as follows:

- **Step 1:** Calculate the *Err* of the obtained signal (sensed signal) against all available data in the database.
- **Step 2:** Select the data with minimum *Err*, i.e., *E*_{closest}.
 - » If *E*_{closest} ≥ *E*_{threshold}, consider the sensed signal as a potential mine and end discrimination.
- **Step 3:** Calculate the measure of difference of errors (*dE*), and make the final decision.
 - » If *dE* > 0, the sensed signal is considered a mine. If *dE* < 0 and $|dE| > dE_{\text{threshold}}$, the sensed signal is considered a metal fragment. Otherwise, the sensed signal is considered a potential mine.

Database-building Experiment

In order to verify the proposed method's validity, a database of characteristic curves (represented by polynomials) was built for multiple targets, depths and postures using a robotic manipulator. The data was taken with a metal mine-detector head at a linear speed of 50 mm/s, with a 10-mm depth step, 10-mm line step between scan lines and a signal output density of 0.2 points/mm. For the following analysis, data with weak signals (*V*(%) < 1%) and saturated signals (*V*(%) = 100%) were removed from the database.

a.				
Case	Test Subject	Closest Match	Discrimination Result	
R1	Metal fragment	Metal fragment	True negative	Good: decrease FAR
R2	Metal fragment	Mine	False positive	Still acceptable: increase FAR
R3	Mine	Metal fragment	False negative	Not acceptable: a missed mine
R4	Mine	Mine	True positive	Good: increase probability of detection
b.				
R3'	Mine	Potential mine	True positive	Good: increase probability of detection

Table 1.a and b. Basic discrimination cases according to *Err* (%). b. After the database conditioning process, case R3 becomes R3'.
Table courtesy of authors/CISR.

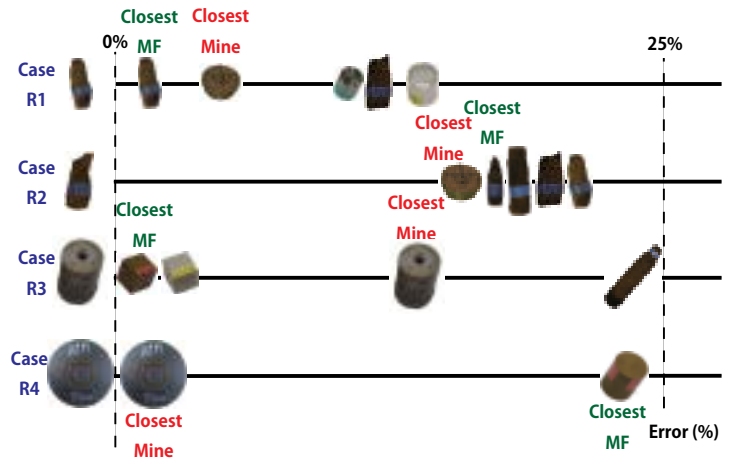


Figure 5. Basic discrimination cases (R1, R2, R3, R4) and target distances according to *Err*.

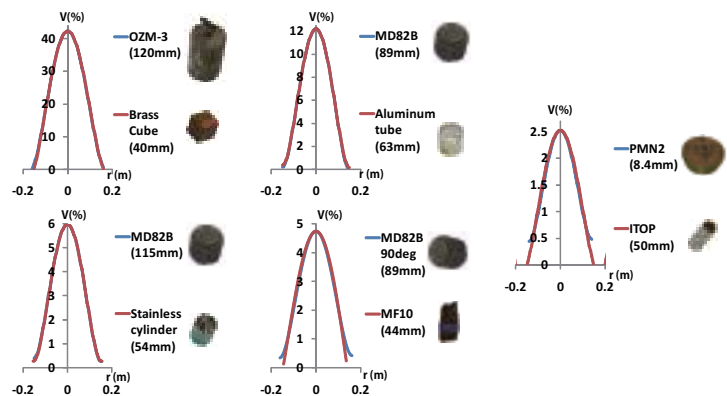


Figure 6. Examples of metal fragments considered potential mines by the *E*_{closest} and $|dE| < dE_{\text{threshold}}$ criteria. Targets and corresponding depths are shown in parenthesis. Note that the International Test Operations Procedures (ITOP) conceived for an ITOP project as the metal content of larger stimulant mines shows SRMMDS very similar to the PMN2 mine and it is also classified as a potential mine by this criteria.

Metal detector signal conditioning. The Minelab F3 Metal Mine Detector was chosen for this experiment.¹⁵ This detector outputs signals in two independent channels (called *Ch*_A and *Ch*_B here), which are combined according to Equation 4 and detailed in endnote 16.¹⁶ *Ch*_C is used to derive characteristic curve *V*(*r*(*θ*)) for comparison in Equation 2.

Equation 4: $Ch_C = Ch_B - Ch_A - \text{median}(Ch_B - Ch_A)$ (4)

Targets description. Figure 7 and Table 3 (page 62) show target types and testing conditions. A total of 42 different targets (11 landmines and 31 metal fragments) consisting of different shapes (cubes, cylinders, spheres, tubes) and materials (aluminum, brass, chrome, stainless, steel), with depths varying from 10 mm to 400 mm, and different

postures (horizontal, inclined 45° and vertical) were tested, which resulted in a total of 362 different data entries into the database. To be more applicable in an operational setting, future research efforts will increase the data library to include a range of minimum metal mines and small minefield fragments.

Database integrity and measure of confidence setting. For each given data N in the database (Table 3, $N = 1$ to 362), consider N as a test subject and calculate the Err (Equation 2) against all other data in the database. The cases (R1, R2, R3 and R4) described earlier are analyzed and shown (sorted for easier visualization) in Figure 8.

To determine $E_{threshold}$, several values from 0 to 100% were set, and corresponding values for false positives and true positives were observed. As Figure 9 (page 63) shows, $E_{threshold} = 10\%$ is the value that maximizes the difference between true positives and false positives.

Expanding Database Capabilities:
Data Interpolation for Different Depths

Case	Type of Test Subject	Type of Closest Match	dE	Discrimination
R1	Metal fragment	Metal fragment	$dE < 0, dE > dE_{threshold}$	True negative
R1'	Metal fragment	Metal fragment flagged as "potential mine"	$dE < 0, dE \leq dE_{threshold}$	False positive
R2	Metal fragment	Mine	$dE > 0$	False positive
R3'	Mine	Metal fragment flagged as "potential mine"	$dE < 0$	True positive
R4	Mine	Mine	$dE > 0$	True positive

Table 2. Discrimination cases: For all the above cases when $E_{closest} \geq E_{threshold}$, test subject shall be considered a potential mine.

Table courtesy of authors/CISR.

	Data Number	Target Type	Dimensions	Main Composing Material	Posture
Not landmines	1-186	Bullets and cartridges (MF01-MF21)	1-27mm diameter, 27-114 mm height	Steel	Horizontal
	187-222	Bullets and cartridges (MF01, MF19, MF21)	7-27 mm diameter, 27-114 mm height	Steel	45° in xz
	223-254	Cube	20 mm edge	Aluminum, stainless, brass	Horizontal
	255-274	Cylinder	11 mm diameter, 12.5 mm height	Aluminum, stainless, brass	Horizontal
	275-291	Tube	11-mm external diameter, 0.5 mm thickness, 12.5 mm height	Aluminum, stainless, brass	Horizontal
	292-301	Sphere	25.4 mm diameter	Chrome	Horizontal
	302-305	ITOP	4.8 mm outer diameter, 0.5 mm thickness, 12.5 mm height	Aluminum	Horizontal
	Landmines	306-330	AT	300 mm diameter	Steel
331-335		PMN	112 mm diameter 56 mm height	Mixture of small alloys	Horizontal
336-340		PMN2	125 mm diameter 65 mm height	Steel	Horizontal
341-362		Other landmines (p-40, PSM-1, MD82B, etc.)	Many variations	Steel	Many variations (horizontal, vertical and 45° in xz)

Table 3. Dimensions of the targets used for building the database.

Table courtesy of authors/CISR.

Preparing a database containing information for every depth and posture may be infeasible in reality. Fortunately, a given target's characteristic curves basically keep the same level of concavity and mainly change in amplitude (a_0) for different depths, as Figure 10 (page 63) shows. For each value of $r(m)$, MMD signals for the main characteristic curves of each depth have a quadratic relation. For example, if the input a_0 is 80%, the estimated depth is around 160 mm for the AT mine and 80 mm for metal fragment 21. This strong relation between depth and signal intensities suggests that we can estimate characteristic curves from a desired depth or vice versa by interpolation (represented in red). In this work, a_0 is used as input for interpolation, which generates a depth and a main characteristic curve for each target and is used for comparison in Equation 2. The data with $E_{closest}$ is then output, providing suggestions for depth, material, posture and target type.¹⁷

Repeating the analysis necessary to measure confidence setting with the interpolation method, smaller values of Err are obtained. In the new threshold, $E_{threshold}$ equals 15% (Figure 11, page 63), and R1, R2, R3 and R4 cases are set. Since no extrapolation is done in the interpolation, part of the data (each target's deepest and shallowest data) is not used. Since depth errors are possible, depth-error margins are also considered; Figure 12 (page 63) shows the analyzed trade-off.¹⁷ For interpolated cases, FAR levels are much lower when compared to the Discrete Data 10 mm case.

Figure 12 shows a FAR analysis conducted in a laboratory with the data from the database. Since potential mines were flagged with the cri-



Figure 7. Targets used for building the database.

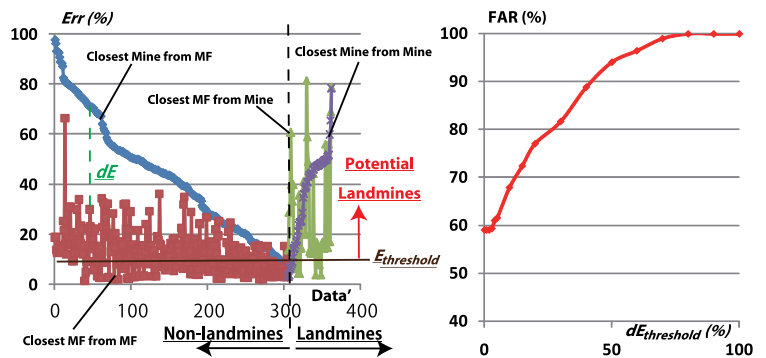


Figure 8. Resulting errors of closest metal fragments and mines from each data. According to the adopted safety margins $dE_{threshold}$ and $E_{threshold}$ different FAR can be observed.

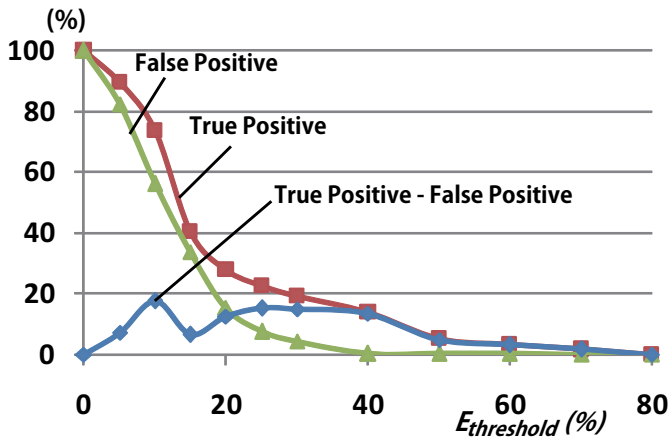


Figure 9. Variation of false-positive and true-positive values according to $E_{threshold}$ (discrete case).

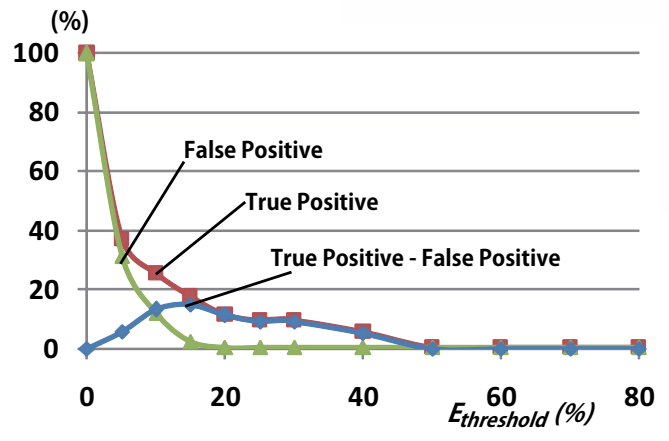


Figure 11. Variation of false-positive and true-positive values according to $E_{threshold}$ (interpolated case).

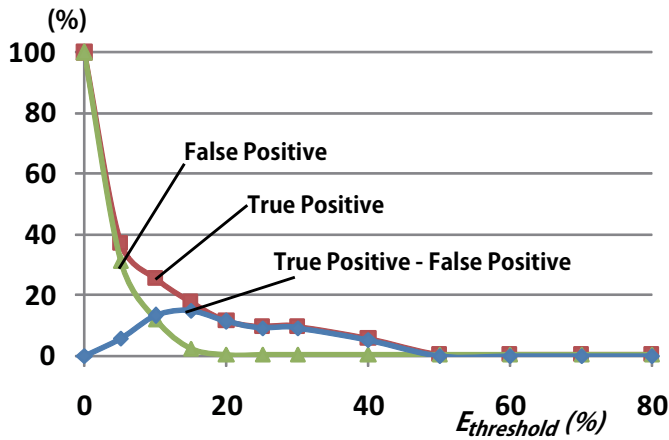


Figure 10. Example of polynomial interpolation for an AT target type MF21 target type. Strong relation between depths and MMD signals permit main characteristic-curves estimation by interpolating the available data in the database.

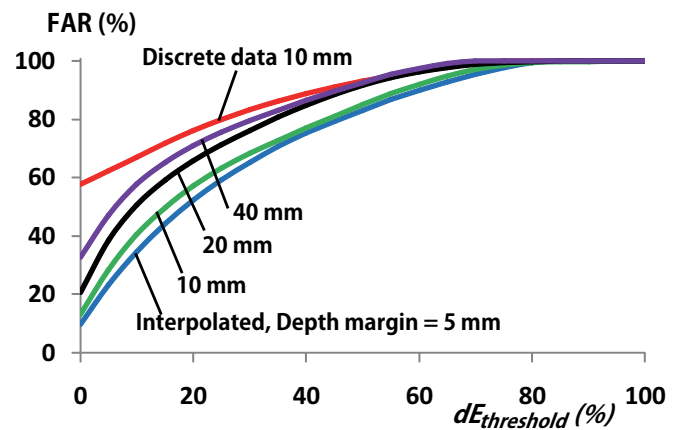


Figure 12. Trade-off of adopted safety margins and FAR. For all cases, FAR is generated with no occurrence of false negatives due to the discrimination criteria and safety margins adopted.

teria shown in the above section on discrimination, Figure 12 shows all cases in which false negatives do not occur, even if $dE_{threshold} = 0$. However, in real demining operations, $dE_{threshold} = 0$ is unacceptable, and a convenient safety margin must be set. In Figure 6 (page 61), an International Test Operation Procedures (ITOP) target resembles a PMN2 mine, and it is considered a potential mine in the discrete case in which $|dE| < dE_{threshold}$ criterion when $dE_{threshold} \geq 10\%$. Therefore, $dE_{threshold} = 10\%$ is adopted. For interpolated cases, Equation 2 identifies an ITOP target as a potential mine. While $dE_{threshold} = 0$ would be enough, a minimum of $dE_{threshold} = 5\%$ is adopted. Moreover, since the maximum depth-estimation error of this method is 40 mm, this depth margin is adopted in real operations.¹⁷

Experimental Results

In this section, data taken in 2007 is used at a test field in Croatia.² The Gryphon robot conducted this test. The test scanned uneven lanes of different soil properties, where several metal fragments and ITOP containing landmine surrogates were buried in random positions at depths between 1 and 14.5 cm. Among the six lanes and 38 targets per lane (180 data points in total, of which 120 were ITOP), 14 ITOP containing landmine surrogates and 14 metal fragments (bullets, rockets, etc.) were chosen to be applied as input in the proposed discrimination method. The data was chosen so that no other metal fragments were nearby, and the position was located within a standard scan area (2 sq m) to avoid cutting data. Table 4 (page 64) shows the safety margins and results.

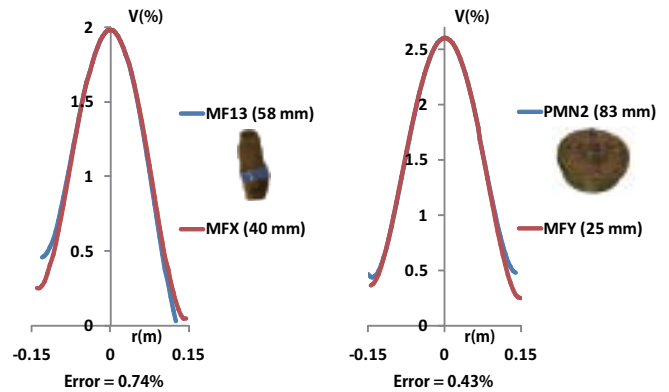


Figure 13. FAR examples: Fragment discriminated as potential mine (left) and fragment discriminated as landmine (right). Each target's depth is shown in parenthesis. MFX and MFY are two metal fragments from the test field, of which size, shape and material are unavailable.

The adopted safety margins guarantee correct detection of all ITOP targets as potential mines. In the laboratory, all ITOP data (in discrete and interpolated cases) are the closest targets to metal fragment 10 (cartridge shown in Figure 7 and Table 3, page 62). In this experiment with ITOP data from the test field, six of the 14 instances for discrete cases and 12 of the 14 for interpolated cases designated metal fragment 10 as the

	Discrete	Interpolated
Ethreshold (%)	10	15
dEthreshold (%)	10	5
Depth margin (mm)	40	40
Metal fragments discriminated as "potential mines" according to Ethreshold criterion	8/14	5/14
Metal fragments discriminated as "potential mines" according to dEthreshold criterion	5/14	1/14
Metal fragments discriminated as landmines by closest data in database	0/14	1/14
FAR (%)	13/14 = 92%	7/14 = 50%
ITOPs discriminated as "potential mines" according to Ethreshold criterion	3/14	0/14
ITOPs discriminated as "potential mines" according to dEthreshold criterion	9/14	13/14
ITOPs discriminated as ITOP itself in vertical posture by closest data in database	1/14	1/14
Discriminated as landmine by closest data in database	1/14	0/14
False negatives	0/14	0/14
Time for discrimination/target (s)	< 1	< 1

Table 4. Parameters adopted and results of the proposed method.
Table courtesy of authors/CISR.

closest target using direct search with Equation 2, which was consistent in the laboratory environment. The ITOP in the upright position in the database (not buried in the laboratory environment) and the safety margin criteria are valid for correct discrimination of data obtained with the Gryphon in soil.

A large number of the metal fragments were discriminated as potential mines in the discrete case due to the *Ethreshold* criterion, which indicates no similar targets exist in the database. This experiment detected eight out of 14 instances for discrete cases and five out of 14 metal fragments for interpolated cases. Due to the method's adopted safety precautions, these results were expected. Adding similar target information to the database would result in more accurate discrimination.

Based on their proximity to some landmines, two of the 14 metal fragments were considered potential mines by *dEthreshold* criterion. Without available information on the test field's metal fragment material, shape or size, they will be known as metal fragment X (MFX) and metal fragment Y (MFY). In in-

terpolated cases, MFX was considered a potential mine for being too similar to the metal fragment 13 cartridge (Figure 7 and Table 3, page 62) and was also considered a potential mine for being too similar to the PMN2 landmine (Figure 13, page 63). MFY was identified as a landmine by direct search, in which a PMN2 was identified as the closest data match (Figure 13, page 63).

The better performance of the interpolated method generates lower FAR levels. Time is another great advantage of using this method; it takes one second per target, which is faster than the false-alarm reduction method endnote 9 references, which takes more than 96 seconds per target.⁹

Conclusions

The above tests of this new methodology for the discrimination of landmines and metal fragments using commercially available MMDs and a prebuilt library demonstrate that this methodology can lead to effective signal characterization and real-time discrimination. Moreover, the methodology to

interpolate discrete data into the database according to its depth makes the evaluation of data in arbitrary depths possible. False positives, which increase FAR, depend on the adopted error-margin criteria. After extensive laboratory tests, thresholds of *Ethreshold* (%) = 15% and *dEthreshold* (%) = 5% were selected, which reduces the FAR to about 50%.

Results from the data analysis obtained in a Croatian test field in 2007 showed the robustness, validity and potential of the proposed method for practical applications. This technology could also potentially help detect unexploded ordnance (UXO) as well. However, additional testing with real UXO and mines, especially low-metal mines, will be needed if that application is pursued. Further tests in real minefields are in development as the next step in this work. This includes tests scheduled for 2014 in Angola that will investigate more types of landmines and metal fragments, as well as other important factors such as soil and climate. ©

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See endnotes page 67



Alex M. Kaneko received a Bachelor of Engineering in mechatronics engineering from the University of Sao Paulo and a Master of Engineering in mechanical and aerospace engineering from the Tokyo Institute of Technology, where he is a doctoral candidate. His research activities include development of demining robots.

Alex Masuo Kaneko
Ph.D. Candidate
Department of Mechanical and
Aerospace Engineering
Graduate School of Science
and Engineering
Tokyo Institute of Technology
2-12-1 Ookayama, Meguro-ku
Tokyo 152-8552 / Japan
Tel/Fax: +81 3 5734 2648
Email: junjyouna.amk@gmail.com



Edwardo F. Fukushima is an associate professor at the Department of Mechanical and Aerospace Engineering of the Tokyo Institute of Technology. His research activities include the development of demining robots, design of controllers for intelligent robots and development of new brushless motors and drives.

Edwardo F. Fukushima, Dr. Eng.
Associate Professor
Department of Mechanical and
Aerospace Engineering
Graduate School of Science
and Engineering
Tel/Fax: +81 3 5734 3175
Email: fukusima@mes.titech.ac.jp



Gen Endo is an assistant professor at the Department of Mechanical and Aerospace Engineering of the Tokyo Institute of Technology. His research interests include mechanical design and intelligent control of mobile robots, especially in legged robots, leg-wheel hybrid robots, assistive mobile robots, educational robots and demining robots.

Gen Endo, Dr. Eng.
Assistant Professor
Department of Mechanical and
Aerospace Engineering
Graduate School of Science
and Engineering
Tel/Fax: +81 3 5734 2774
Email: gendo@mes.titech.ac.jp

U.S. and Vietnam Sign MOU by Cunningham [from page 6]

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3. "Vietnam." *Landmine and Cluster Munition Monitor*. Last modified 30 August 2013. <http://bit.ly/MaS3oW>.
4. "Vietnam." Mines Advisory Group. Last modified 30 August 30 2013. <http://bit.ly/1eWpfb0>.
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Outcome Monitoring in Humanitarian Mine Action by Nedergaard [from page 7]

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4. Refer to the humanitarian accountability partnership (HAP) of which DDG is a partner. Accessed 20 August 2013. <http://tinyurl.com/c3wyyt>.
5. For more discussion, see Simister, N. "Developing M&E Systems for Complex Organisations: A Methodology." *INTRAC M&E Paper 3*. October 2009. Accessed 20 August 2013. <http://tinyurl.com/luwowk9>.
6. Chambers, Robert. "The Power and Potential of Participatory Statistics." Presentation at the Institute of Development Studies, University of Sussex, Brighton. 22 April 2013.
7. An informal mine action M&E practitioners meeting was held in Copenhagen to facilitate more knowledge-sharing on data collection within the sector. The meeting took place 2-3 July 2013 and included the following participants: UNMAS, UNDP, UNOPS, GMAP, MAG, NPA, DCA, GICHD and DDG.
8. After this article was written, a Statement on Outcome Monitoring in Mine Action was developed as a joint effort within the sector. The statement sets principles and guiding indicators for outcome monitoring in mine action. HI, MAG, NPA, DCA and DDG all signed up to the principles in the statement. Accessed 21 February 2014. <http://bit.ly/1l5lCRm>.

Amendments to the IMAS Land Release Series by Gray [from page 11]

1. The updated versions (07.11 Land Release, 0810 Non-technical Survey and 08.20 Technical Survey) are available to download at <http://bit.ly/LPNUWP>.

Effects of Mixed Teams on Land Release by Bini, Janssen and Jones [from page 14]

1. Baseline assessments were conducted in Afghanistan, Democratic Republic of the Congo, Iraq, Lebanon, Libya and South Sudan (two different organizations). These assessments were conducted for different organizations and have not been published.
2. Note that all answers from respondents represent their personal views and experiences and do not always reflect GMAP's views.
3. The land release process encompasses the efficient application of survey and clearance and the subsequent handover of land.
4. "Cartagena Action Plan 2010–2014: Ending the Suffering Caused by Anti-personnel Mines." *Cartagena Summit on a Mine-Free World*, Action No. 15, 20 and 52. Cartagena de Indias, Colombia, 30 November–4 December 2009. <http://bit.ly/19c4WaL>.
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6. United Nations Mine Action Service. *IMAS 07.11: Land Release*. Section 5. New York: UNMAS, 10 June 2009. <http://bit.ly/1fd3F4t>.
7. Gender and Mine Action Programme. "Gender-sensitive recruitment and training in mine action: Guidelines." Geneva: GMAP, 2013. <http://bit.ly/1aOjvNU>.

Scalable Technical Survey for Improved Land-release Rates by Bach [from page 17]

1. Subdivision is normally only applicable to mine survey.
2. The latter implies, as a minimum, considerable increase in the percentage coverage during grid clearance, but more often it implies full clearance over the entire area if patterns are not determined. TS should not be considered light clearance of areas with low densities of mines. The latter would imply some form of risk mitigation, which is not the purpose of TS and may also be a violation of the conventions.
3. This process is less applicable when searching for CMR and not applicable when searching for other ERW.

Managing Residual Clearance: Learning From Europe's Past by Paunila [from page 22]

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Environmentally Responsible SAA Disposal by Biddle [from page 26]

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Conventional Munitions Disposal Capacity Development in South Sudan

by Commandant Francis O'Grady [from page 29]

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Lessons From Lebanon: Rubble Removal and Explosive Ordnance Disposal by Lauritzen [from page 32]

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Applying NGO Resource-mobilization Strategies to the Mine Action Community by Sosniecki and Fiederlein [from page 38]

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Quality Management Systems in Mine Action Programs by Simon and De Coninck [from page 42]

1. Standard Operating Procedures (SOP) are specific operational procedures for mine action activities. SOP are evaluated against either International Mine Action Stan-

dards or national standards before use in the field. SOP can be adjusted relatively quickly to suit specific situations.

- Standard Work Procedures (SWP) are an organization's internal procedures related to documentation, reporting and administration. Sometimes these are also called work practices. Depending on the organization, these are not easily changed and normally rely on a periodic formal review to have changes implemented. SWP are normally part of a QMS.

Typhoon Haiyan Leaves Ordnance Contamination in its Wake by Feigleson [from page 45]

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Mercer University Professor Provides Prosthetics in Vietnam by Qualliotine [from page 50]

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