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THE JOURNAL

OF ERW AND MINE ACTION

Issue 15.3 | Fall 2011

Focus:
Cluster Munitions

Feature:
**Government Stability &
Mine-action Support**

Plus: Notes from the Field
and Research & Development

THE JOURNAL

OF ERW AND MINE ACTION

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Cluster bombs, such as these in Lebanon, continue to kill civilians in many countries of the world. Photo courtesy of Hugh Macleod/IRIN.

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

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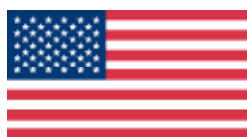
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LETTER FROM THE EDITOR

Dear Readers,

Since Ken Rutherford became the Director of the Center for International Stabilization and Recovery in February 2010, *The Journal* team and the rest of the CISR staff have been blessed with his insight, energy and creativity. He is a dynamic leader whom we admire, and he is well respected throughout the world. Many of you know him as cofounder of Landmine Survivors Network (later Survivor Corps, now defunct), a landmine survivors' advocacy and support group. While Dr. Rutherford continues as a personal champion of survivors' and other disability rights, as CISR's Director, he is also broadening and deepening the Center's vision and mission to develop, implement and deliver global programs that make a difference, and publishing the premier information source for the humanitarian mine-action sector, this journal.

The Journal of ERW and Mine Action is focused on programming. Yet, we have recently received an increasing number of articles promoting various issues—often entirely outside of *The Journal's* scope (such as the ongoing Arms Trade Treaty negotiations). It is time to clearly state what topics we will publish and what articles we are interested in receiving.

The Journal is a professional trade journal for the HMA and ERW community. The first two-thirds of the publication is devoted to topics that interest a wide variety of HMA and ERW industry people—field, management, programming, training, academic and government personnel. The last third of *The Journal* focuses on new or emerging technologies and scientific studies that contribute to more effectively expanding the discussion regarding innovative methods to clear and/or neutralize mines and ERW.

The Journal is a forum for HMA and ERW-clearance best practices and methodologies, strategic planning, mine-risk education and survivors' assistance. We love case studies discussing projects/programs: what happened, who was involved and supported the project, successes, failures and ideas for improvements. By highlighting the good work you do in the world, we help readers learn, grow, innovate and do more good. Kindly remember, however, that without donors, you would be unable to do as much for the world, so please acknowledge their support in your articles.

Although we want to hear about the many good things you do, please ensure your articles are substantive. In this issue we feature many interesting and informative articles, including a summary of NPA's project on the Thailand-Cambodia border, articles about the situation in Libya and a story about Afghanistan's community-based demining teams.

In addition, we welcome your contributions to our website forum and commenting features. I invite you to use these tools to tell the world what you think.

Lois Carter Fay
 Editor-in-Chief
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Calendar of Events

November 2011

- 9-10: Fifth Conference of the High Contracting Parties to CCW Protocol V,
Geneva, Switzerland
- 11: Thirteenth Annual Conference on Amended Protocol II
Geneva, Switzerland
- 14-25: Convention on Conventional Weapons 4th Review Conference
Geneva, Switzerland
- 28-12/2: Mine Ban Treaty 11th MSP
Phnom Penh, Cambodia
-

December 2011

- 3: Three-year Anniversary of the Convention on Cluster Munitions
Signing Conference
- 3: International Day of Persons with Disabilities
- 10: International Human Rights Day
-

January 2012

- 1: Deadline for Guinea-Bissau to Complete Implementation of
Anti-Personnel Mine Ban Convention Mine-clearance Obligations
-

March 2012

- 1: Thirteenth Anniversary of the Entry into Force
of the Anti-Personnel Mine Ban Convention
- 1: Entry into Force of the Anti-Personnel Mine Ban Convention for Tuvalu
- 31: Suggested Deadline for States Parties to the Anti-Personnel Mine Ban
Convention with Article 5 Deadlines in 2013 to Submit Requests for Extensions
-

April 2012

- 24-26: The 9th International Symposium Humanitarian Demining 2012,
Sibenik, Croatia
- 30: Deadline for States Parties to the Anti-Personnel Mine Ban Convention
to Submit Updated Transparency Information Covering Calendar Year 2011
-

*For more details on these and other events visit
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Survey and Clearance of Unexploded Submunitions Versus Landmines and Other ERW

The authors argue that survey and clearance methods in areas contaminated solely by unexploded submunitions (from cluster munitions) should be different than those in areas contaminated by mines and other explosive remnants of war to achieve the most efficient outcome. This article seeks to explain how and why procedures are different, and proposes a land-release methodology for dealing with unexploded submunitions.

by Åsa Gilbert and Michael Creighton [GICHD]

Traditionally, the systematic clearance of explosive hazards is grouped into two main categories: landmine clearance and battle-area clearance.

While the land-release principles are similar for both, the operational methodologies applied to each category are different. Since mines are designed to be victim-activated, they pose a more direct risk to clearance technicians than do submunitions, which are designed to detonate before, upon or after impact. Thus, if mines and ERW are in the same area, the situation should first be treated as a mine-hazard problem and then as an ERW hazard.

Addressing areas contaminated by unexploded submunitions is classified as a BAC activity, but the operational procedures used are, in many ways, similar to mine clearance. Therefore, a truly efficient operational approach to the clearance of submunitions must incorporate aspects of BAC and mine-clearance procedures.

Characteristics of CMs and Explosive Submunitions

Because of the characteristics outlined below (pattern, metal content, failure rate and risk of accidental functioning), the land-release methodology for submunitions can, and should be, distinct from mine clearance and other ERW clearance.

Pattern. The clearance of submunitions is distinct from the clearance of mines and other ERW, largely due to the unique patterns of dispersal and explosion exhibited by cluster munitions. Thus, in order to efficiently handle submunitions, clearance teams must not rely heavily on standard operating procedures used in mine clearance. Instead, techniques must be used for submunition identification and clearance that reflect the unique nature of cluster munitions, taking into

account the scattering pattern, metal content, failure rate and risk for accidental detonation of submunitions.

- **Cluster munitions/submunitions.** Cluster munitions are distinct from other munitions. When fired, launched or dropped, the explosive submunitions are dispersed or released, and create a strike pattern or **footprint** on the ground. Unexploded submunitions will undoubtedly be within this footprint area, because of the high failure rate of explosive submunitions, as discussed later in this article. By identifying the footprint's shape, the center

Convention on Cluster Munitions Article 2 definitions as used in this article¹:

Cluster Munition: a conventional munition that is designed to disperse or release explosive submunitions, each weighing less than 20 kilograms, and includes those explosive submunitions

- **Explosive Submunition:** a conventional munition that in order to perform its task is dispersed or released by a cluster munition and is designed to function by detonating an explosive charge prior to, on or after impact
- **Unexploded Submunition:** an explosive submunition that has been dispersed or released by, or otherwise separated from, a cluster munition and has failed to explode as intended



An example footprint/pattern of 155 mm delivered explosive submunitions. The impact marks in this photo show the extent of the footprint.

Photo courtesy of FFI, the Norwegian Defence Research Establishment.

and outer edge of the strike can be better determined. This facilitates a more precise, systematic search of the hazardous area.

- **ERW.** In general, explosive remnants of war such as aircraft bombs, mortars and artillery shells, do not create a predictable pattern or footprint after being fired or delivered but may be concentrated in certain areas.
- **Mines.** Mines are often laid in rows and set patterns, so methodologies can be developed to assist clearing patterned minefields. Even when mines are laid randomly (generally known as nuisance minefields), it may still be viable to identify and analyze the laying tactics. Therefore, it is possible to determine areas likely to be mined and release areas that have no evidence of mines.

Metal content. Normally, submunitions contain significantly more metal than regular anti-personnel mines or non-metal cased anti-vehicle mines. This means that less sensitive detectors/locators, such as magnetometers, that are not sensitive enough to detect mines can be used effectively to detect the more metallic submunitions.

Failure rate. Research indicates that the failure rate of submunitions varies, but could be as high as 30 percent. Compared to other ERW types, this is considered high. The high failure rate is a result of several factors. The most dominant factor is linked to the arming process and fuze design, but other factors, such as quality of materials, storage procedures, weapons release conditions, weather and type of terrain may all contribute to the failure of submunitions to detonate.²

Each cluster munition holds a large number of submunitions (up to several hundred in each container). This, coupled with the high percentage that fail to detonate, can create a grouped pattern of unexploded submunitions, i.e., the footprint as discussed previously in this article.

Risk of accidental functioning. Fuzing of explosive submunitions varies, depending on the make and model. Most

types are designed to detonate on impact with the ground or target. This is different from mines, which are generally designed to be victim-activated.

Unlike AP mines, the risk of activating a submunition below the surface by stepping on the ground above it is usually considered very low. Therefore, the area of a suspected submunition strike can usually be accessed to conduct survey activities. The principle to note is that unexploded submunitions should not be compared to AP mines, which in most cases, are victim activated.

It should be emphasized that accessing areas contaminated by unexploded submunitions should only be conducted by trained technicians. Even though unexploded submunitions do not pose an immediate threat to explosive ordnance disposal personnel as AP mines do, this should not be misunderstood as a lack of danger to the local population. Unexploded submunitions remain a danger to these communities and should be dealt with accordingly; however, on a procedural level, the risk of accidental functioning during clearance is much lower in the case of submunitions than with landmines.

Land-release Methodology

The footprints, or dispersal patterns, of submunitions can be used for more efficient survey of contaminated land. Teams can use the identification of one submunition as an indication of the presence of more submunitions in the same area, due to their high failure rate and dispersal characteristics.

Even if the conflict occurred several years earlier, or if a large number of the submunitions were moved and/or destroyed, the presence of one submunition remains a reliable indication of other submunitions in the area. In the case of overlapping strikes, locating the point where the footprints end is necessary. This requires clear and agreed working procedures on how to plan and conduct survey and clearance.

Sometimes the drills and equipment used during submunition survey and clearance are similar to those used in mine clearance, e.g., a systematic search below ground using detectors. However, using mine-clearance procedures and equipment during the survey and clearance of submunitions is highly inefficient, and should be avoided whenever possible. This is because the metal content is significantly higher in submunitions than in mines, and submunitions are not designed to be detonated by applying pressure. Nevertheless, because of the cost and logistical challenges involved in purchasing new equipment, when an organization undertakes the survey and clearance of submunitions, it may have to employ detectors designed to detect minimum-metal mines and use procedures developed for mine clearance.

| | Pattern | Metal Content | Failure Rate | Risk of Accidental Activation (accessibility during survey) |
|--------------|--|-----------------|---|--|
| Mines | Laid in a pattern or placed for tactical reasons | Low/Medium/High | Not applicable | Victim activated No access to the area during survey |
| Submunitions | Create a pattern or footprint as a result of their delivery or dispersal process | High | Variable - can be as high as 30% | Designed to function by detonation prior to, on or after impact Possible to access the area during survey in most cases |
| Other UXO | Generally no pattern | High | Depends on type, but in general lower than for submunitions | Generally designed to detonate on impact Possible to access the area during survey |

Summary table. Different characteristics of mines, submunitions and other UXO.
Graphic courtesy of the authors.

Submunition survey and clearance, therefore, can generally be conducted using more rapid and effective procedures than for mine clearance. These procedures provide several advantages, including the following:

- **Quicker search procedures.** When the contamination type contains a high metal content and does not include pressure/victim-activated devices, the search can be faster. In most cases, it is considered safe to conduct a surface search by walking the suspected area, coupled with vegetation cutting (if needed), to allow a more thorough ground search.
- **Quicker marking.** Depending on which working procedures are used, a less comprehensive marking system may be justified. A systematic search below ground may require a more complex marking system; however, some techniques, such as a surface-visual search, may allow for an expedited, less comprehensive marking system.
- **Quicker site set up/take down.** As a result of the less comprehensive marking system, the site set-up and take-down will be less time-consuming.

Although land-release methodologies for submunitions may not be as straight forward as for a patterned minefield, similar land-release principles, like the use of an evidence-based approach and the principle of all reasonable effort, should be applied. For instance, heavy contamination, intended land use or other factors may demand slower, more meticulous clearance procedures, which draw more heavily on mine-action principles.

Evidence-based Approach

A proposed methodology for the survey and clearance of submunitions is an evidence-based approach, that is, when clear evidence indicates the presence of submunitions, this method can be used, including when:

- Evidence of a strike is confirmed by either physical debris or a strong claim (by an informant).
- An evidence point is created, and from this point further survey/clearance commences.

Evidence-point criteria. The national mine-action authority and operators should develop and agree upon the criteria for the required level of evidence needed to create an evidence point. In general, however, when any of the following are present, an evidence point can be established:

- Unexploded submunitions
- Fragmentation of submunitions
- Parts of the delivery systems
- Strike marks
- Fragmentation marks
- Burned areas
- A strong claim by an informant stating that unexploded submunitions are located in the area

In some countries, suspected hazardous areas can be linked to boundaries that have been determined by the affected community. As people with no mine/ERW experience (local residents) tend to define these areas, however, civilians generally think the contaminated areas are larger than they actually are. As a result, assets are deployed to areas where no



Strikemark dual-purpose improved conventional munitions M77.
Photo courtesy of Åsa Gilbert.

evidence of contamination exists, instead of in evidence-based confirmed hazardous areas.

For effective use of resources and planning purposes, estimated areas may be attributed to each evidence point. The community should be closely involved in the process of identifying evidence points. However, this area should not be seen as an actual hazardous area, nor the boundaries as the extent of any contamination. Well-defined criteria will ensure that only land qualifying for further technical survey/clearance will be recorded and tasked for future activity. As stated previously, the local population should be involved in the process, but the final decision should be evidence-based and made by technically-qualified staff, following defined criteria.

Initial response. In the initial post-conflict phase, the rapid removal and destruction of surface-located submunitions is necessary in order to remove the immediate threat to the local inhabitants. During this process, there may not be enough time to gather and record all available information. Most importantly, a minimum record should be kept and entered into a

database, such as the specific location (using a Global Positioning System) of each individual item, the munition type found and the number of items destroyed. These records will facilitate the analysis of the data at a later stage. Also, sufficient and accurate recording of each item's location enables the footprint of the strike to be identified later and technical survey/clearance assets to be efficiently deployed in contaminated areas.

Mine-action programs often have roving EOD or rapid-response teams that carry out spot tasks (removal of individual munitions found) on an as-needed basis. As with the above example, a detailed record is very important for keeping all tasks, and this record should be incorporated into the later planning and tasking of technical survey/clearance teams.

Non-technical Survey. Before conducting a Non-technical Survey, a desk assessment should take place, analyzing previous survey records, EOD spot-task records and bombing data (if available). Then, the NTS teams should deploy to the field to investigate any previously recorded suspected-hazardous areas/evidence points and identify any new ones.

Fade-out. A fade-out is the agreed distance from a specific evidence point where the Technical Survey/clearance is carried out. The fade-out distance is determined by the conditions specific to the area (i.e., geographical conditions, hazard type, delivery methods, etc.) and should be based on operational experience.

Technical Clearance Process as Illustrated in Figures A and B:

1. Identify evidence of submunitions
 - Unexploded bomblets
 - Fragmentation
 - Strike mark
 - Strong claim
2. Start clearance at the location of the evidence.
3. Clear x meters in all directions according to the agreed distance for FADEOUT from evidence (wx. 50m).
4. If no further evidence has been found, stop clearance.
5. If no further evidence has been found/ reported in the area, the CHA is released.

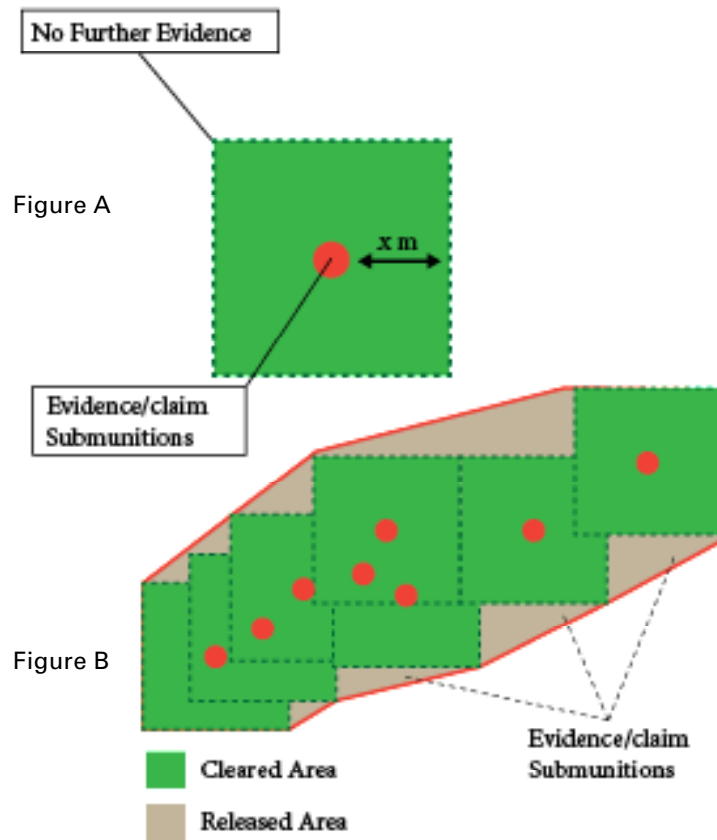


Figure A (top). One piece of evidence was found in the area. Clearance starts at the location of the evidence (red dot). If no further evidence is encountered within the fade-out (x meters in all directions from the evidence operationally conducted as a box search), no additional survey/clearance is required.

Figure B (bottom). Three separate locations with evidence were identified during the initial NTS. The survey team identified a hazardous area polygon based on the evidence. During the survey/clearance operation, all evidence was dealt with individually. When applying the fade-out and if additional evidence is found, the survey/clearance is extended. If no further evidence is found, the remaining area is released.

If credible evidence corresponding with the correct level outlined in national standards and standard operating procedures is not found, the survey team should not record an evidence point or a hazardous area. This is essential for the validity of an evidence-based methodology, and avoids inflating the problem by populating the database with hazardous areas based on vague information or weak claims not based on any actual evidence.

Conversely, if sound evidence is available and the NTS team can clearly identify evidence of cluster-munition remnants, an evidence point should be recorded. If enough clear evidence exists to determine which specific area is contaminated, then the survey team should document the boundaries of the contamination. This can provide better planning information for further Technical Survey and clearance. However, this should only be done if the boundaries of the contamination area can be clearly identified.

Technical Survey and clearance. Once an NTS team conducts a survey and if a hazardous area or an area identified by an evidence point is identified, the area is then subjected to Technical Survey and/or clearance. The two activities are generally conducted concurrently, even though some organizations employ separate specialized Technical Survey and clearance teams.

With an evidence-based approach, the task is carried out in the same manner, whether the area only requires a surface search or if items are below the surface. The team commences the Technical Survey/clearance at the evidence point's location and then works its way outward to the agreed fade-out point.

If no other submunitions are found once the fade-out distance is applied and searched, it is reasonable to determine that no other submunitions remain from that strike/footprint. To give an example, if the fade-out is 50 meters (54.68



Surface Search - Visual.
Photo courtesy of Asa Gilbert.

yards), the ground will be processed for a distance of 50 m in all directions from where the evidence point is located. If no further evidence is found, the survey/clearance will stop. A total of 10,000 square meters (2.47 acres) will have been technically surveyed/cleared.

Conclusion

Submunitions are different from mines and other ERW in a number of ways. Because of these unique characteristics, it is an advantage to develop a unique land-release methodology for the survey and clearance of submunitions so that the most efficient approach is used.

Although some mine-clearance procedures are also suitable for submunition survey and clearance, it is important that more efficient procedures specifically tailored to cluster-munitions identification and removal, including establishing the submunitions footprint, are used when possible. ◆

See endnotes page 82



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NPA's Survey and Clearance of Cluster Munitions Along the Thailand-Cambodia Border

The February conflict at the Thailand-Cambodia border over disputed territory has left Cambodia with the burden of clearing cluster munitions. By applying to the Thai-Cambodian conflict strategies for cluster munitions removal that were successful in other post-conflict areas, NPA is assisting the Cambodian Mine Action Centre in cleaning up the problem. Thailand and Cambodia have not acceded to the ban on cluster munitions established in the 2008 Convention on Cluster Munitions and are therefore not subject to its provisions. Both countries attended the CCM 2011 intersessional meeting in June, leaving many hopeful that the two countries will become States Parties.

by Atle Karlsen [Norwegian People's Aid]

Thai and Cambodian troops exchanged fire 4–7 February 2011 over disputed territory along the border near the Preah Vihear temple in northern Cambodia, a UNESCO World Heritage site. On 10 February, the Cambodian Mine Action Centre reported it had evidence that Thai forces fired cluster munitions into areas in Preah Vihear province.

Funded by the Norwegian Ministry of Foreign Affairs, Norwegian People's Aid began a new survey project in Cambodia in 2011 to establish the extent of the cluster-munition remnants problem across the country using methodologies developed through NPA's work in Lao PDR, Lebanon, Serbia and Vietnam. CMAC asked NPA to conduct an emergency survey of the affected areas. Simultaneously, in Thailand, in cooperation with the Thailand Mine Action Center, NPA conducted a survey of the sites on the Thai border that were attacked with Cambodian artillery during the February conflict.

Neither Thailand nor Cambodia has acceded to the *Convention on Cluster Munitions*, but positive statements by both nations during the CCM's first intersessional meetings offered hope that they would join the CCM soon. Follow-up meetings, in Cambodia and Thailand in mid-August 2011 included military-to-military dialogue on the obligations of the CCM and alternative, more cost-efficient ways to destroy cluster-munition stockpiles.

Assessment of the Situation

On 1 and 2 April 2011, a delegation from NPA, CMAC and the *Landmine and Cluster Munition Monitor* visited Cambodia's affected areas. The objectives of the assessment were to confirm cluster-munition use in Preah Vihear province (number



M85 SD in Cambodia

All photos courtesy of Stephanie de Gref, Landmine and Cluster Munition Monitor.

of sites contaminated/types of munitions used) and to assess the impact of cluster-munition contamination on the population. In Sen Chey village the assessment team found that cluster munitions had hit several houses and people were living among the unexploded submunitions.

The assessment team recorded the locations of all unexploded munitions found, and evidence from cluster-munition strikes was gathered (spacers/ribbons, fragments, etc.). It was confirmed that Thailand delivered the cluster munitions by artillery, namely the 155mm NR 269. The assessment also determined that unexploded M42/M46 contaminated the area.



M85 with ribbon.

CMAC identified 12 cluster-bomb-unit strike sites, and the initial priority recommended by the assessment team was to conduct a rapid but systematic survey of the contaminated areas through visual instrument-aided inspection. Based on the assessment, CMAC requested NPA to provide technical support and use the survey teams for future battle-area clearance of the contaminated areas. While the land has yet to be

cleared, CMAC has used the NPA survey to restrict the contaminated area and conduct mine-risk education for the local people. No accidents have occurred since.

Deployment of NPA/CMAC Teams

Upon agreeing to assist CMAC, NPA contracted a technical advisor to supervise the training and deployment of survey

management staff, the four survey teams and one explosive-ordnance-disposal team to Preah Vihear province.

The teams conducted appropriate training on BAC operational procedures, provided instruction on technical aspects of cluster munitions in particular, and deployed to the area 1 May 2011.

The teams were deployed to three high-priority areas and between 1 May and 13 June 2011 cleared the following areas:

1. Sen Chey village: 117,500 square meters (29 acres)
2. Thomcheat resettlement village: 305,000 sq. m. (75 acres)
3. Area 911¹: 497,601 sq. m. (123 acres)

The total area the NPA/CMAC teams cleared was 920,101 sq. m. (227 acres). The methodology of the clearance operations was based on the NPA standard operating procedures from Lebanon, and the teams used the Minelab F3

plosive remnants of war. However, the knowledge of the threat expected is important. Normally, the threat picture in Southeast Asia would consist of slightly less dangerous submunitions (like the BLU-26, BLU-3 B and BLU-24 B), but in the case described above, survey teams found the newer and more dangerous M85 type² submunition, which changed the way the SOPs for clearance were developed. Unexploded M85 SD submunitions with self-destruction mechanism were found armed and not detonated.

Good surveying of cluster-munition remnants is potentially more efficient than is the case with, for example, landmines, as more and often better quality data is available up front (bombing data coordinates, numbers and types of ordnance used). The Cluster Munition Coalition called on Thailand to release data on target coordinates and numbers

| Items/TASK | Sen Chey | Thomcheat | Area 911 | Spot tasks | Total |
|--------------|----------|-----------|----------|------------|-----------|
| M42 | 1 | 6 | 0 | 8 | 15 |
| M46 | 0 | 0 | 0 | 0 | 0 |
| M85 SD | 0 | 0 | 6 | 0 | 6 |
| Total | 1 | 6 | 6 | 8 | 21 |

Table 1. (Clusters per task) Items of cluster munitions found in Cambodia during survey.

metal detector for all visual instrument-aided surface searches. The performance of the teams was excellent, as observed from the productivity figures. NPA transferred procedures and knowledge on cluster-munitions clearance to CMAC management staff and its EOD team. The clearance of the remaining contaminated areas in Preah Vihear was continued from 1 July 2011 by other CMAC clearance-capacity resources.

Lessons Learned

The clearance of cluster-munition remnants, including unexploded submunitions, is not in and of itself particularly difficult, and many international organizations have cleared various ex-

and types of cluster munitions used since this could have greatly assisted the survey.

Finally, in many affected countries, a thorough survey establishes the location of cluster-munition remnants; contributes to a greater understanding and real estimation of the contamination problem; and determines where cluster-munition remnants are not a threat. Further, a quality survey allows people in unaffected areas to continue with their lives in safety, and prevents the wasteful use of scarce clearance resources in unaffected areas. ◆

See endnotes page 82



Atle Karlsen is the Country Director for Norwegian People's Aid in Lao PDR, he also worked as Regional Director for NPA in Southern Africa, based in Mozambique. Since 2009, Karlsen has worked as Policy Advisor for NPA, representing NPA on the International Campaign to Ban Landmines and the CCM. Karlsen holds a master's degree in development economics from the University of East Anglia, U.K. and another master's degree in international management from the BI Norwegian School of Business Management, Oslo, Norway. He is a member of the editorial board of the *Landmine and Cluster Munition Monitor*, and has worked on strategies, results management and quality assurance for NPA for the last 10 years.

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25 August 2021

This article has been temporarily removed. We apologize for any inconvenience.

Sincerely,
The Journal of CWD

News Brief

The EU and the U.S. Provide Grant to Lao PDR

MAG (Mines Advisory Group) has recently been tasked with a new project to collaborate with the UXO sector in Lao PDR to clear UXO from Boualapha, Mahaxay and Xatbuathong of Khammouane province. Valued at 700,000 euro (US\$975,026),¹ the European Union and the United States cosponsor the project, with the EU contributing 600,000 euro (US\$835,613)¹ and the U.S. Government granting US\$142,721¹ (102,442 euro)³. In addition, the EU plans to launch another UXO program in 2012.² The EU promised the Lao Government a grant for this clearance project if it fulfilled its UXO obligations under the *Convention on Cluster Munitions*.²

On 8 July 2011, the EU issued its first funding disbursement for the new MAG clearance project; this is the fourth partnership between the EU and MAG, and it builds on previous funding by the European Commission.³ From 2000 to 2010, the EC and various EU member states provided roughly 29 million euros (US\$39,438,046)² in assistance to Lao PDR.⁴ During that same time period, the U.S. dedicated more than \$36 million (25,844,700 euros) to UXO action in Lao PDR. In 2010, the United States contributed \$5,102,000 (3,662,687 euros) for mine-action support to the country, of which \$1,400,000 was used to fund MAG operations.⁵



A villager shows community liaison staff unexploded bomblets in Nong Boua village, Lao PDR.
Photo courtesy of Sean Sutton/MAG.

According to MAG Country Programme Manager David Hayter, the opportunity for MAG to work with local authorities will ensure optimal use of resources; moreover, MAG will complete a UXO survey for the National Regulatory Authority—Lao PDR's UXO and landmine organization—and provide land clearance for contaminated areas within Khammouane province.^{1, 3} [↗](#)

See endotes page 82
~Blake Williamson, CISR Staff

Mine-action Challenges and Responses in Georgia

Following an international conflict in 2008, Georgia faces a greater threat from landmines and explosive remnants of war than that posed by previous violence. In response to this threat, Georgia, with assistance provided by the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) and the Government of Canada, created national bodies to coordinate and implement landmine and ERW clearance. This article documents Georgia's past ERW, landmine and cluster-munitions contamination, as well as efforts to remove these threats.

by Emil M. Hasanov [iMMAP/ERWCC] and Petri Nevalainen [iMMAP]

Georgia is party to the *Convention on the Prohibition on the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and their Destruction* (also known at the Anti-personnel Mine Ban Convention or APMBC), and acceded to Protocol V on ERW on 22 December 2008 and to Amended Protocol II on Landmines on 8 June 2009.

According to Article 6 of the Georgia Law on International Treaties, international treaties are an integral part of Georgian legislation, and the provisions of these treaties establish specific rights and obligations that are enacted directly without requiring adoption of additional laws or regulations.¹

Landmines and ERW in Georgia

The landmine problem in Georgia is primarily a result of landmine use around former Soviet/Russian military bases along international borders and from conflicts with the breakaway republics of Abkhazia and South Ossetia.² Georgia had neither the authority nor the responsibility to clear these bases while they remained under Russian control. However, Russia transferred the last of the military bases located in Georgia to

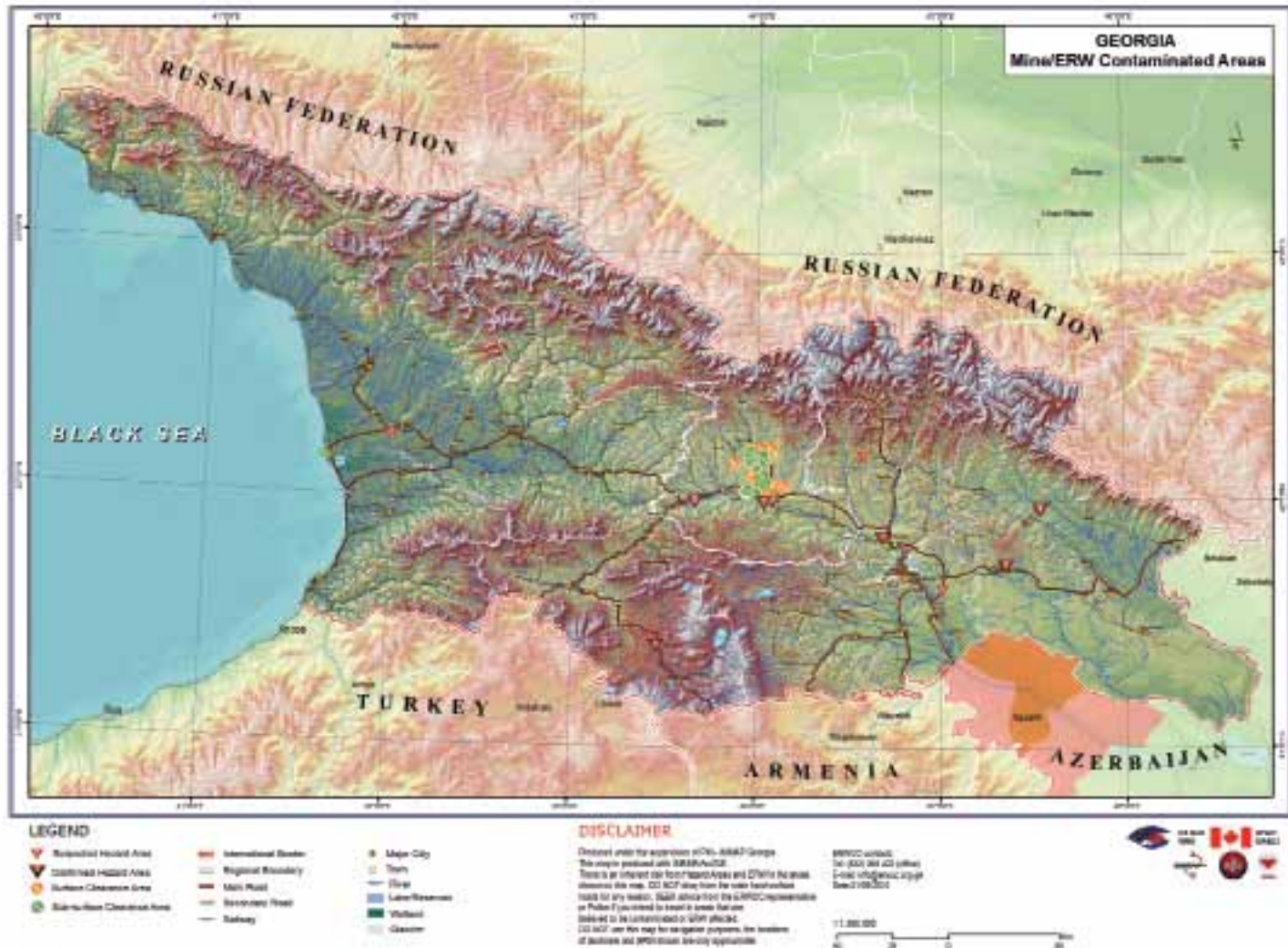


Russian checkpoint.
All graphics courtesy of ERWCC Georgia.

Georgian authority in November 2007, allowing authorities to begin clearance operations.³

In addition to landmines, Georgia is faced with unexploded cluster submunitions as a result of the conflict between Russia and Georgia in August 2008. This conflict created a serious threat of ERW and cluster-munition injuries to the Georgian population at large. The impact

of this contamination was most noticeable from the Shida Kartli region north of Gori to Tskinali in South Ossetia. Additionally, aerial-delivered bombs and missiles that targeted areas in Poti harbor, Kopitnari, Batumi (Black Sea coast) and around Tbilisi contributed to an increased ERW threat and impact. The increased ERW contamination added to prior problems that Georgia faced from



Level of ERW, landmine and cluster-munition contamination in Georgia as of November 2010.

legacy Soviet/Russian minefields, as well as the existing ERW threat in the Abkhazia region.⁴

Georgia has not acceded to the *Convention on Cluster Munitions*. Georgian officials stated in a letter to the *Landmine and Cluster Munitions Monitor* in April 2010, “The Georgian government has expressed its support to the spirit of the Mine Ban Treaty and the Cluster Munitions Convention, but the bitter reality on the ground with reference to the security situation in the region didn’t allow us to adjoin the mentioned conventions. Unfortunately the situation has not changed much and has even worsened security-wise that does not leave us any option other than to stay reluctant to join the conventions until the credible changes occur in the security environment of the region.”⁵

Russia used cluster munitions near towns and villages in the Gori-Tskhinvali corridor near the South Ossetia administrative border of Georgia during the August 2008 conflict. According to a Human Rights Watch report, Russian clus-

ter-munition strikes on populated areas killed 12 civilians and injured 46 during this period.⁶ As a result, unexploded submunitions affected populated and agricultural areas, posing a threat to the civilian population. Russia produced and stockpiled the cluster-munition types used in the August 2008 conflict (AO-2.5 RTM and 9N210 submunitions, RBK series bombs, Uragan rockets and Iskander missiles). Georgia reports possessing RBK-500 bombs, but they are no longer active and are slated for destruction.⁷

Georgia also used cluster munitions, including M85 submunitions in Mk 4 160mm rockets (Georgia procured these weapons as packages from Israel) during the August 2008 conflict.⁵ Regarding the Human Rights Watch report, the Ministry of Defence stated Georgia launched 24 volleys of GRADLAR Mk 4 rockets, each volley containing 13 of the weapons. While these rockets can have unitary warheads as well, assuming all 13 contained cluster munitions would result in a total of 32,448 M85 submunitions.⁷

Currently the threat of ERW, cluster munitions and landmines around former military facilities and in some border areas outside the South Ossetia borders continues to endanger the civilian population. Furthermore, potentially productive land is unusable due to the contamination, preventing the government from undertaking numerous socioeconomic development projects. These projects include agricultural development in the Shida Kartli region and tourism expansion on the Black Sea and at important religious sites, such as Mskheta.⁸ On the other hand, The HALO Trust completed clearance of Abkhazia and a ceremony was held on 4 November 2011 to acknowledge completion of this project.

the Ministry of Internal Affairs Explosive Ordnance Response Teams. On 9 October 2008 a Memorandum of Understanding was signed between the Georgian Ministry of Defence and the international nongovernmental organization, the Information Management & Mine Action Programs.⁹ PM/WRA tasked iMMAP to support the Georgian Government in establishing the Explosive Remnants of War Coordination Center to address the ERW problem resulting from the conflict and to assist in coordinating clearance of the legacy minefields. Although ERWCC began operations in October 2008, the official opening was held on 25 February 2009 in Tbilisi.¹⁰ According to Deputy Defence Minister Giorgi Muchaidze

“...that does not leave us any option other than to stay reluctant to join the conventions until the credible changes occur in the security environment of the region.”

Norwegian People's Aid conducted a General Mine Action Assessment funded by the International Trust Fund for Demining and Mine Victims Assistance. Between October 2009 and January 2010 the governments of Hungary and the Czech Republic funded this assessment through ITF. The GMAA identified eight suspected hazardous areas and seven confirmed hazardous areas in 13 districts, the latter of which totaled more than an estimated 4.5 square kilometers (1.73 square miles).

Mine-action Coordination in Georgia

Immediately following the August 2008 conflict many international humanitarian-aid agencies rallied to provide emergency response support. Several international organizations, including the European Union Monitoring Mission, the International Committee of the Red Cross, ITF and the International Campaign to Ban Landmines - Georgia, engaged in humanitarian mine-action activities in Georgia, but these activities lacked coordination. The Georgian Government had discussed for several years how to best address the legacy landmine issue, but had not until the recent conflict, realized the importance of coordinating HMA activities. Two primary demining operators were identified: HALO and NPA. HALO already operated in Abkhazia, the breakaway autonomous region of Georgia, and established the Abkhaz Mine Action Office there in 1999; NPA deployed demining teams in Georgia through the end of June 2010.

At the national level, demining capacity was represented by Georgia's Ministry of Defence Brigade of Engineers and by

who spoke at the launch, “It is more important to reorganize the above mentioned office as a national mine action center, which would be a step forward for struggling with this problem.”¹¹ iMMAP and other stakeholders determined through an assessment that there was an urgent need to develop local capacity for HMA activities, as well as for Georgia to establish national HMA standards and technical safety guidelines derived from the International Mine Action Standards.

On 23 October 2008, the Georgian Ministry of Defence and the Slovenia-based ITF signed a two-year Memorandum of Understanding on HMA assistance. ITF initiated a national capacity building program in January 2009 that followed ERWCC's general goals. Among other things, the program focused on providing assistance to national authorities in HMA capacity building.¹²

ERWCC Operations

iMMAP engaged the Ministries of Defence and Internal Affairs through Memorandum of Understandings and worked closely with other Georgian authorities. ERWCC became the Georgian entity tasked to coordinate and execute ERW mitigation and is responsible for external quality assurance/quality control of HMA activities (Canada's Department of Foreign Affairs and International Trade initially funded QA/QC activities). Through iMMAP's guidance, the ERWCC continued to coordinate HMA activities in Georgia, as well as conduct QA/QC and act as the national HMA authority. These activities and responsibilities were transferred to the Georgian Government in early 2011. During the lifespan of



An ERWCC hazard assessment in Perevi, Georgia.

the ERWCC, the tasks and responsibilities that were identified included the following:¹³

- QA/QC of demining/clearance activities
- QA/QC of unexploded ordnance and explosive hazard clearance and disposal
- Battle-area clearance
- Mine-risk education
- ERW information management from any conflict or source
- Community liaison
- Stockpile reduction
- Advocacy

The ERWCC hosted regularly scheduled coordination meetings with all major HMA stakeholders in Georgia. These stakeholders included international NGOs, the Georgian Red Cross, the Georgian Ministries of Defence and Interior, and the Georgian Army Brigade of Engineers. These meetings were held biweekly or as requested by the parties involved for the purpose of synchronizing and monitoring HMA activities. ERWCC also established mechanisms to assist other NGOs and international institutions (United Nations agen-

cies, EU Monitoring Mission, etc.). When suspected contamination is reported and rapid assessments are required, clearance plans are made jointly with the appropriate stakeholders. ERWCC conducted several risk-assessment missions during 2010 to survey potential new hazardous areas. An example is Perevi village, where the Ministries of Defence and Interior requested that the ERWCC conduct an ERW hazard assessment after Russian troops withdrew from the village at the western border with South Ossetia on 18 October 2010. Russian forces in the Perevi area controlled the main road in Perevi village, which links nearby South Ossetia villages to the rest of the breakaway region. ERWCC found evidence of the use of cluster-munitions and other ERW and provided this information for further action, such as mine risk education, victim assistance and clearance.

Transition and Georgian Ownership

On 30 December 2010 the Georgian Ministry of Defence issued a decree instructing that HMA be included as part of a Ministry body known as the State Military Scientific Technical Center, or DELTA.¹⁴ DELTA has now assumed the



An IMAS training course at ERWCC.

HMA coordination role, though existing ERWCC structure and operations are threatened due to lack of funding. ERWCC has largely halted operations, with the exception of an emergency follow-up clearance operation in Mskheta. The organization hopes to resume clearance activities with technical assistance from the Azerbaijan National Agency for Mine Action and funding from the Georgian Ministry of Defence and NATO.

IMAS and QA/QC training courses were conducted for ERWCC staff (mainly the QA/QC section), the Joint Staff of the Georgian Armed Forces and DELTA, with funding and assistance from PM/WRA. The aim of this effort was to increase the level of knowledge regarding HMA and to prepare for handover to Georgian ownership. The final handover of ERWCC to DELTA occurred in the beginning of 2011. ♦

Note: This article covers operational activities in Georgia until March 2011.

See endnotes page 82



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Conflict Resolution in the Twenty-first Century: Principles, Methods, and Approaches

by Jacob Bercovitch and Richard Jackson
 University of Michigan Press, August 4, 2009
 ISBN: 9780472050628
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 US\$32.50



In *Conflict Resolution in the Twenty-first Century: Principles, Methods, and Approaches*, Bercovitch and Jackson create an accessible and well-organized analysis of the best approaches to resolving conflicts in the world today. Emphasizing fundamental changes in the nature of conflict following the Cold War, the authors present the argument that conflict resolution must also change. Their analysis characterizes pre-1991 conflicts as primarily interstate conflicts or power struggles between states and insurgents, overseen and manipulated by the major powers. According to the authors, the collapse of the Soviet Union saw “the proliferation of ethnic, religious, cultural, and resource-driven conflicts as major threats to international peace.” This shift rendered traditional methods of resolving conflicts practically obsolete, forcing innovative thinking to produce a new understanding of peace building.

Bercovitch and Jackson, both from the University of Canterbury, New Zealand, describe traditional approaches—international negotiation, conflict mediation, arbitration and adjudication, U.N. conflict resolution and peacekeeping—and explain how these methods must evolve to meet the needs of the modern world. They analyze new methods—preventive diplomacy, humanitarian intervention, regional task-sharing, nonofficial justice, and reconciliation—as approaches arising from a philosophy of participatory social interaction, which views peace as the result of positive cultural transformation rather than a state imposed by a paternalistic superstructure. Additionally, they view nongovernmental organizations as crucial actors in implementing this new methodology because of their moral credibility and independence from power politics. Concise, well-referenced and eloquent, this book outdistances other weightier tomes in defining a peace-building agenda for the future. 

Reviewed by Cameron Macauley, CISR staff.

Clearing Minefields in Israel and the West Bank

Recent legislation in Israel has opened the door to demining in Israel and the West Bank. Roots of Peace campaigned for this legislation and will begin demining a village near Bethlehem before the end of 2011.

by Dhyana Or and Heidi Kühn [Roots of Peace]



Palestinian youth cycles past a minefield near Bethlehem.
Photo courtesy of Roots of Peace.

The Mine-Free Israel campaign, a humanitarian effort led by a coalition of organizations comprised of Roots of Peace, the Association for Civil Rights in Israel, the Center for Regional Councils, Council for a Beautiful Israel, local authorities from mine-affected communities and landmine survivors, has paved the way for humanitarian demining in Israel and the West Bank.¹ The campaign recently helped pass unprecedented mine-action legislation in Israel and raise public awareness about mines in the West Bank. According to the new law, the Israeli government established a national mine-action authority, with an annual budget of 27 million NIS (US\$7.3 million),^{2,3} scheduled to begin humanitarian demining in Israel in early 2012. In order to mirror this policy shift in the West Bank, Roots of Peace, the coordinator of the cross-sector coalition mentioned above, adopted a minefield in Husan, a Palestinian village near Bethlehem and raised funds to begin demining there before the end of December 2011. With help from several foundations and individuals, including a legacy gift from Shirley and Paul Dean of

Spiriterra Vineyards, Roots of Peace will remove the landmines and transform the field of death in the midst of Husan village into a field of life, where fruit trees can grow once again, and boys and girls can safely walk and play.

Minefield History

More than 1.5 million landmines laid during the 1950s and 1960s contaminate a combined area of 50,000 acres (200 square kilometers) in the Golan Heights, in the Arava Valley and along the Jordan River.⁴ This includes more than 300,000 landmines contaminating 5,000 acres (20 sq. km.) of agricultural and residential land in the West Bank, with unexploded ordnance further making sites inaccessible.⁵

Mined areas in the region include some religious and World Heritage sites of high significance to Christianity, Islam and Judaism, especially the site known as *Qasr el Yahud* (Palace of the Jews) where many believe Jesus was baptized,⁶ Joshua crossed the Jordan River⁷ and Prophet Elijah is believed to have ascended into heaven.⁸ Approximately 3,000



Minefields and sacred sites in Israel and the Palestinian Authority.
 Figure courtesy of Avner Goren/Survivor Corps.

anti-personnel and anti-tank mines, as well as booby traps, surround ancient monasteries and places of worship belonging to a variety of religions and held sacred by billions of people around the world.⁹

Husan is a Palestinian village located about 4 miles (6 km) west of Bethlehem and 6 miles (10 km) southwest of Jerusalem, with a population of 6,000 people,¹⁰ half of which are children, and an area of 1,800 acres (7.4 sq. km.), 87 percent of which are classified as Area C¹¹ administered solely by Israel. The remaining area is classified as Area B, jointly administered by both the Palestinian Authority and Israel.¹² Between 1949 and 1967, a Jordanian police station surrounded by a mixed minefield (containing both AT and AP mines)¹³ overlooked the Jordanian-Israeli border from a hill within Husan. In 1993, when a bypass road (No. 375) was paved through the minefield to connect Beitur Illit with Jerusalem, it split the minefield into two parts: one part, south of the road, is fenced and marked and consists of 4.5 acres (18,211 square meters) of grazing and agricultural land; and the second part, north of the road, within a residential area of Husan, consists of 1.5 acres (6,070 sq. m.), and is unmarked, posing a constant threat to residents, especially children, who pass through it daily. Traces of

an old barbed-wire fence, as well as one worn-out yellow sign can be found around this minefield.¹⁴ Over the years, several mine incidents have occurred in Husan, resulting in loss of lives and limbs.

In the past 20 years, several attempts at partially demining the area were made without success.

In August 2000, British demining nongovernmental organization MAG (Mines Advisory Group) completed a technical assessment of the Husan minefields for the Canadian Landmine Foundation and planned to conduct a 12-week clearance of the contaminated area, but the clearance was put on hold due to the outbreak of the Second Palestinian Uprising (*Intifada*). In June 2001, during this *Intifada*, the Israeli military bulldozed two small sections of the southern minefield in order to erect a watchtower on a hilltop overlooking Husan. Additionally, the military shoveled mine-contaminated soil onto the northern minefield to allow the erection of a metal fence between Husan and the bypass road to protect cars from *Intifada* stone-throwers.¹⁴ This redistribution of dirt and contaminants further polluted the northern minefield.

In 2002, at the urging of the NGO World Vision and the Palestinian charity Health Work Committees, MAG attempted to conduct demining in Husan but failed to secure the Israeli authorities' approval and the project did not materialize.¹⁵ Once the *Intifada* subsided, the Israeli courts granted permission to the landowners residing along the edge of the northern minefield to clear the contaminated land. The Israeli military insisted that only a designated, army-approved, private Israeli firm could conduct the demining, and local residents would have to bear the cost, which was well above their means. Then in 2010, Israeli advocacy group *Yesh Din* approached private Israeli demining firms on behalf of Husan landowners in an attempt to negotiate a low-cost demining contract. Even though *Yesh Din* found a military-approved firm to demine Husan, this firm's estimated cost to complete the work was unaffordable, and the firm required landowners to sign a **No-Shop Agreement** prohibiting them from obtaining a more competitive bid.¹⁶



A marked minefield near Hatzera, Israel.
 Photo courtesy of Roots of Peace.

Israeli Policy Shift

Despite repeated landmine and UXO incidents, until 2011 no mine-action policy existed in Israel. Several failed attempts at introducing a mine-action legislation from 2002 to

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The Center for International Stabilization and Recovery has historically been the information clearinghouse for humanitarian-demining activities. Heidi Kühn, founder of Roots of Peace, calls *The Journal of ERW and Mine Action* "The pre-eminent source for strategic, global landmine removal." With the recent addition of **The CISR Sphere**, *The Journal* takes information-sharing to the next level through an easily accessible social network. The mine-action community can now gather, network and absorb the latest in mine-action news online in a number of new ways.

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Landowners view the mined area around their homes.
 Photo courtesy of Roots of Peace.

2004 failed due to lack of public support.¹⁷ However, after an intensive public-relations campaign inspired by 11-year-old local landmine survivor Daniel Yuval¹⁸ who lost his leg to a landmine in the Golan Heights in 2010, 73 out of 80 rank-and-file members of parliament cosponsored the Minefield Clearance Act which was eventually passed, with active support of the government and the Prime Minister on 14 March 2011.¹⁷ According to the new legislation, the Israeli National Mine Action Authority was established, and tasked with the creation and implementation of the first national humanitarian-demining plan. In September 2011 INMAA published the first draft of the national mine-action standards, held a first meeting of its advisory committee, which includes members of government offices and public representatives, and announced two pilot projects in the upper Arava Valley to be conducted in 2012.

Demine-Replant-Rebuild Initiative in the West Bank

According to Israeli and international law, the Israeli law does not apply to the West Bank, where the Palestinian Authority and the Israeli Defense Forces have shared control of civilian and security affairs. Still, the recent policy shift was welcomed by both the PA and the IDF, and raised expectations for a parallel change in mine-action policy in the West Bank. In Husan, local residents, who have been disappointed time and again after failed appeals for the removal of the constant threat of landmines from the midst of their village, are expressing renewed confidence in the possibility of realizing this wish. Once cleared, the land could be returned to productive use, helping boost local economy, which is characterized by high unemployment rates.¹⁹ Following clearance, the local community is planning to replant olive trees, expand the homes of the large families living around the



Roots of Peace Founder Heidi Kühn and Tzachi Hanegbi, Chair of the Israel Foreign Affairs Defense Committee, plant a tree in Israel in July 2010.
Photo courtesy of Roots of Peace.

minefield, and construct their first playground for hundreds of Husan children who have no other place to play.

The Roots of Peace Demine-Replant-Rebuild initiative is a humanitarian interfaith program seeking to bring peace from the bottom-up by removing landmines and replanting the cleared land with traditional plant species (often considered sacred) such as pomegranates, grapes, figs, dates, olives, wheat and barley. Roots of Peace will launch its initiative in the Bethlehem area before the end of 2011 in partnership with the PA and the local council, with a local demining group working according to internationally recognized practices and standards, in coordination with the IDF, and under strict cost and quality management. No demining organization has yet been chosen; the contracting process is still under way.

Looking to the Future

Roots of Peace's pilot humanitarian-demining project in Husan, scheduled to launch before the end of 2011, will set a precedent of local-international cooperation in mine action in the country, help build humanitarian-demining capacity and pave the way for public-private partnerships which will allow for the eventual clearance of all mine-affected communities in the West Bank and the sacred sites along the Jordan River. ◊

See endnotes page 82



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The Impact of ERW on Children

This article provides a brief description of the threat cluster munitions, landmines and other explosive remnants of war pose to children worldwide. The discussion of children's physical susceptibility and the psychological and socioeconomic effects that accompany wounds and disabilities provides a broad picture of the impact ERW have on children. The article also explores rehabilitative support, as several sources provide a variety of recovery strategies that focus on community support for the future well-being of child survivors.

Known as **killing fields** in Cambodia and **devil's gardens** in Afghanistan, areas contaminated with explosive remnants of war are known for their impartiality when claiming victims, the majority of whom are children.¹ In Southern Lebanon, submunitions continue to injure and kill children returning home after the 2006 Israeli-Hezbollah War when they mistake them for toys.² In Lao PDR, infamously the most bombed country in the world, children returning home from school are killed by handling submunitions they find on the roadside.³ In May 2011, a submunition, which the victim believed to be a ball,⁴ killed a 13-year-old boy from Western Sahara who was herding animals, and an old cluster bomb killed three boys ranging in ages six to 12 while they were playing in a garden in Southern Iraq.⁵ Also, Libyan children living amidst the ongoing civil war suffer injuries from cluster munitions and indiscriminate mortar and rocket fire.⁶

Global Picture

While civilians constitute roughly 70 percent of all casualties caused by cluster munitions, landmines and other ERW, the *Landmine and Cluster Munition Monitor* reports that children make up one-third of casualties worldwide.⁷ UNICEF reported that from 2008 to 2010, children accounted for half of all civilian casualties.⁸ Among child casualties, boys constitute the highest percentage where the gender is known, composing nearly three-fourths of all ERW casualties.⁷ In fact, 10 countries report boys as their largest casualty group.⁹ ERW, however, also affect girls who are often more stigmatized for injuries. Their disabilities are seen as burdens to families, and as a result, girls represent an under-reported statistic.⁹ Along with an unfamiliarity of the various types of explosives and a tendency to play or work in hazardous areas, natural curiosity and a smaller body size render children more susceptible to the effects of ERW than adults.



Children from Lao PDR's Khammouane province draw dead-bomblets from cluster bombs that still litter their playgrounds more than 30 years after the war ended.

Photo courtesy of Sean Sutton/MAG.

Susceptibility of Children

Since rural areas are most often affected, using land for farming, grazing, hunting, collecting firewood and various other activities often brings civilians into contact with ERW.¹⁰ An inability to read and heed warning signs leaves children susceptible to mines, and their playful nature often leads to mistaking submunitions as balls, rations, soda cans or toys.¹¹ Furthermore, the presence of these explosives can effectively nullify the land's agricultural capability, affecting a community economically while also threatening the community's physical well-being, as the threat of detonating ERW is as potent as malnutrition and starvation.¹² Inhabitants may be compelled to use the land for less lucrative purposes to avoid

activities that risk contact with unexploded, subsurface submunitions and mines, effectively reducing the family income while increasing its vulnerability.¹³ Alternatively, affected land does not always prevent inhabitants from taking risks to earn a living. To provide for their families those suffering from poverty in Cambodia, Lao PDR, Lebanon and Vietnam often feel they have no alternatives except to scour contaminated land for scrap metal. In fact, an increase in unexploded submunition accidents in Lao PDR between 2003 and 2005 can be attributed to an increase in the scrap-metal trade.¹⁴

When compared to mines, areas affected by cluster munitions may give inhabitants a false sense of security, because people trust in their ability to avoid unexploded submunitions that they believe are predominantly visible.¹⁵ On the other hand, many Cambodian farmers, although aware of the subsurface dangers, cannot afford to wait for contaminated land areas to be cleared and will plow fields in spite of the risks involved.¹⁶ This can result in additional child casualties because the explosive charges of cluster munitions are much greater than those of anti-personnel mines and can easily injure others nearby.^{13,16} In subsistence cultures where victims are frequently farmers, herdsmen or refugees, injury is especially devastating since day-to-day survival depends heavily on physical abilities.¹⁰

Given that a high percentage of ERW are found in rural areas, up to 25 percent of victims live from one to six hours away from medical care providers.¹⁰ In Lao PDR, areas contaminated with cluster munitions may be a several-hour walk from the nearest paved road.¹³ Remoteness and the low positioning of vital organs leave child victims highly vulnerable to the concentrated explosive blasts of mines, submunitions and other ERW. Physical injuries caused by AP mines typically include the loss of one or both feet or lower limbs, and extensive shrapnel damage to the pelvis and abdomen.¹⁷

In a comparative study on the effects of landmines and ERW among children and adults in Cambodia, Cino Bendinelli wrote that children “sustained more invalidating disabilities, such as upper-limb amputation and bilateral blindness.”¹⁶ This increased severity of injuries was associated with a child’s tendency (especially boys) to pick up and handle unexploded ordnance, sustaining more upper-body injuries, whereas adults were injured most frequently by mines, resulting in lower-limb injuries.¹⁶ Notably, cluster munitions pose a greater threat because these explosives are specifically designed to kill, whereas most AP mines are designed to incapacitate and wound.¹³ In “The Consequences for Children of Explosive Remnants of War,” Hugh Watts notes that for those fortunate enough to reach medical care, children

“typically undergo multiple operations requiring large ... quantities of transfused blood, on average more than six times as much blood as those injured by bullets or fragments.”¹²

After sustaining injuries, child survivors suffer severe long-term effects. The underdeveloped nature of a child’s body requires multiple operations, and several amputations may be necessary as bones grow at a faster rate than soft tissue.¹⁸ Learning to use prosthetic devices is an important component of rehabilitation, and in addition to multiple follow-up surgeries, a child “may need up to 35 prostheses/modifications during his or her lifetime.”²¹²

Psychological Effects

The effects of ERW are not limited to children with sustained injuries. An inability to understand war may heavily affect a child’s psychological well-being, as one’s daily routine becomes highly unpredictable.¹² Mental-health issues often result from traumatic experiences. In a report entitled “100 Incidents of Humanitarian Harm,” authors Esther Cann and Katherine Harrison report that children have been known to suffer “flashbacks, nightmares and hysterical aphonia, a psychological disorder in which a person loses the ability to speak following a traumatic event.”¹⁹ While the terror involved in such a traumatic experience affects children, survivors are also influenced by their family’s inability to cope with resulting disabilities; this often results in guilt.²⁰ Moreover, community rejection or the rejection of one’s family can lead child survivors to feelings of depression.²⁰

Socioeconomic Impact

Whereas children are highly susceptible to the physical and psychological impacts of encountering ERW, accompanying socioeconomic effects can also be detrimental to a child’s life. School attendance is low among child survivors, and stigma and isolation in developing countries mean that many children have little hope of receiving proper rehabilitation.¹² In addition, the presence of ERW on many roads and paths makes travel to hospitals or clinics hazardous.⁸

Regardless of whether the children sustain physical injuries, many are still greatly affected by the socioeconomic impact of a family member’s disability. When parents are unable to provide for themselves or their families, children may be obligated to drop out of school in order to earn a supplemental income and help support the family.¹⁷ In addition, this phenomenon contributes to a child’s vulnerability to ERW, since families suffering from severe poverty may require children to work in hazardous areas for the purpose of providing income.¹⁷



Unexploded ordnance for sale in Xiang Khouang, Lao PDR.
Photo courtesy of Paulo Kawai.

In a post on *The Blog of Physicians for Human Rights*, Deputy Director Richard Sollom relates the story of a young Burmese refugee, a boy tending to his buffalo in an infected area when a mine claimed his left leg and severely injured his right leg.²¹ Although Sollom writes that the story is one of success—the boy received surgery, care and a prosthetic leg—Sollom noted that the boy will be unable to attend school and must continue to tend to his buffalo, the same venue that resulted in his injuries.²¹

Rehabilitative Support

Socioeconomic reintegration may be difficult for children suffering amputations and disabilities as appropriate programs are often unavailable. Moreover, peers often do not understand disability issues, and teachers are unable to prevent isolation

or exclusion of child survivors.¹² The need for corrective surgery and the continuous need for replacement prosthetics is also problematic, as families suffering from poverty cannot afford such treatment. Unfortunately, measuring assistance to child survivors can be difficult since many service providers do not commonly record detailed statistics; consequently, the exact nature of treatment provided to child survivors is largely unknown.⁹ According to the *Landmine and Cluster Munition Monitor's* 2010 report, the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and their Destruction* (also known as the Anti-personnel Mine Ban Convention or APMBC) implicitly requires landmine survivors and their families to participate in the convention's implementation and be fully involved in victim-assistance activities.⁷ Provided that friends and family are



Hmong children pose by the fence made with unexploded ordnance in Xiang Khouang, Lao PDR.
Photo courtesy of Paulo Kawai.

offering support to survivors, Save the Children, an international nongovernmental organization, noted that these existing forms of local support should not be overlooked when seeking to implement new forms of support, such as the introduction of professional aid workers.¹⁸

In their book *Globalization, Social Justice and the Helping Professions*, William Roth and Katharine Briar-Lawson write that “the chief tenet for working with victims of trauma is to, first and foremost, *remove the threat*, but the truth is that the vast majority of traumatized children continue to live within or close to the killing landmine fields.”²⁰ In order

to provide appropriate support, child survivors ought to be considered in the context of their age, culture and community.¹⁸ Programs should be structured around capacity-building for not only the child, but also the child’s family.¹⁸ Roth and Briar-Lawson assert that children who have suffered physically and psychologically will progress more quickly in the rehabilitation process when staying with family; similarly, children who have been separated from family members tend to fare better when placed with a foster family.²⁰

While the threat of bodily harm involved in accidentally detonating a mine, unexploded submunition or some

other ERW is evident, the psychological and socioeconomic impacts on a child’s life are less obvious. Children are physically scarred and mentally traumatized, and when families are unable to cope with a disability, the family becomes more vulnerable to the socioeconomic after-effects of the incident. Children require specialized rehabilitative care and additional ongoing support. By understanding the various effects these weapons can have on a child’s life, more appropriate, sustainable care can be provided to those in need. ◊

See endnotes page 82
~Blake Williamson, CISR Staff

New Database Provides Resource for Mine-action Community

Launched in July 2011, the World Bank's Landmine Contamination, Casualties and Clearance database is a valuable resource for those working in mine action. The database allows users to create spreadsheets, reports and graphics based on a wealth of landmine-contamination data from around the world.



Screen shot of World databank homepage. The Landmine Contamination Casualties and Clearance (LC3D) database is only one of 27 databases published by the World Bank. All graphics courtesy of <http://data.worldbank.org>.

The World dataBank, <http://data.worldbank.org>, is an informational database launched 20 April 2010 by the World Bank as a part of its Open Data Initiative.¹ Within the databank are 27 separate databases containing information on topics ranging from finances and debt to the conditions of African railways. These databases are free and open to the public as a part of the World Bank's mission to disseminate facts for journalists, academicians and other concerned parties. Most of the datasets are updated annually, although some economic and social datasets are available on a monthly or quarterly basis.² According to its website, the World Bank hopes that this sharing and publicizing of information will lead to greater transparency and accountability because the World Bank acknowledges these attributes as "essential to the development process and central to achieving the Bank's mission to alleviate poverty."³

The Database

Recently, the World dataBank has expanded to include a new dataset: Landmine Contamination, Casualties and Clearance. Added in July 2011, this database draws from two data sources, the *Landmine and Cluster Munition Monitor* and the United Nations Mine Action Team, to provide accurate information regarding landmine and unexploded-ordnance contamination in 192 countries.⁴

Users can create their own reports on the website by selecting the countries for which they want data; the source from which they would like the data; the specific variable measures or the specific data figures they would like to see; and the time frame for which they would like the data. Thus, the data, which cover most aspects of mine action, are divided into certain groupings that are broken down further according to more specific variables. The four main groupings of data are:

1. Country
2. Data source
3. Series
4. Time

Under the **Country** heading, information is organized into sections titled Income, Lending and Region. Under the **Income** heading, countries are divided into five sets, organized according to levels of income. Under the **Lending** section, countries are split into two groups: low-income countries receiving interest-free loans and higher-income countries receiving humanitarian loans for specific projects.⁵ Finally, under the **Region** heading, data is divided into seven different regions: East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, North America, South Asia, and Sub-Saharan Africa. These groupings provide users with a variety of criteria for country-data selection.

Once users have selected a country, or a group of countries, they must then select the data source. Sometimes the information found in both the *Landmine and Cluster Munition Monitor*



After entering the World dataBank, users can select any of the 209 countries in the database.



On the Format Report page, users can export their data into Excel, view their data, or proceed to a customizable report page, which allows users to view data, create graphics and build charts.

and the UNMAT is the same; however, often, one source provides information for a variable that the other does not. For example, for the variable **Total area cleared (square kilometers)**, no data from the *Landmine Monitor* is displayed, whereas data from UNMAT is shown.

Next, the user must choose the **Series** variables. Series variables are the individual statistical measures, such as whether the country is a signatory to the *Convention on Cluster Munitions* and/or a States Party to the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (also known as

the Anti-personnel Mine Ban Convention or APMBC). Series variables include casualty statistics, clearance and landmine destruction statistics and information on national and international mine-action funding.

Many individual statistical measures cover a vast body of information in the database, but the World dataBank system is easy to navigate. Breaking down each group of data into specific subgroups dramatically reduces the difficulty of sifting through large reports for a specific statistic. However, the most beneficial aspect of the dataBank is its **Format Report** feature, which allows users to create single-variable spreadsheets on its website.

The reports can be downloaded to a Microsoft Excel spreadsheet, but the online report generator gives the spreadsheets an interactive quality. For instance, the online report format allows the user to easily switch between different variables and different sources using the pull-down tab at the top of the screen. This feature enables users to create customized reports and compare data across many variables.

The database also allows users to create graphics and charts from selected data. This feature facilitates easy visual comparison, allowing users to compile helpful graphic data representations. **Map view** displays data on a world map, an innovative addition to an already quite comprehensive graphics feature.

One aspect of the database, however, is less helpful. In some cases, the two sources provide very different data for the same variable. For example, UNMAT data for **Civilians killed, total** shows much lower numbers for Afghanistan than the *Landmine Monitor* data displays. This discrepancy does not reflect a failure on the part of the World dataBank, but instead highlights the issues of using varied, non-standardized data-gathering and reporting techniques.

Conclusion

The World dataBank's Landmine Contamination, Casualties and Clearance database is a useful and innovative resource for anyone interested in mine action or cluster munitions. The site's navigation is intuitive and easy to learn. As the site develops and information becomes more comprehensive, the database will become an important resource for the mine-action community. ◀▶

See endnotes page 83
~Jeremiah Smith, CISR Staff

The Information Management & Mine Action Programs

The Information Management & Mine Action Programs use information management and technology to increase humanitarian mine-action safety and efficiency. The work conducted in Iraq, which supports mine-clearance and victim-assistance activities, is an example of iMMAP facilitating improved information sharing in HMA. In addition, these improved information-management activities allow iMMAP to provide ongoing victim-assistance services to persons with disabilities in Iraq and to other patient populations.

by Eric Sawyer [iMMAP]

Since the late 1990s, attacks on humanitarian relief-and-development workers have steadily grown. Factors contributing to this rising threat include increasingly unstable environments, an expansion in the number of deployed relief-and-development workers, and the erosion of humanitarian neutrality and independence. This increase has been difficult to quantify due to the lack of coherent data concerning security incidents, as well as other contextual information such as disaster events and explosive remnants of war-related data.

The safety-and-security information gap hampers relief-and-development efforts by the United Nations and other national and international nongovernmental organizations. Without this information, personnel lack a sound basis upon which to make safe operational and policy decisions. The Information Management & Mine Action Programs strive to decrease the dangers of these operations by compiling critical data in an efficient manner to facilitate better decision-making by project managers, logistics officers, security managers, field workers and other nontechnical personnel who make daily decisions affecting the safety of personnel and agency field operations.

Tools

In 2006, iMMAP developed a solution to fill the security-information gap—the Operations Activity Security Information System. This technology was introduced in Iraq and is used by numerous U.N., nongovernmental and response organizations in Afghanistan, Colombia, Georgia and Pakistan. Building on a common operating picture by compiling dispa-



Figure 1. Layout of OASIS software.
All figures courtesy of the author.

rate event and operations data in one place, OASIS allows users to achieve a comprehensive situational awareness.¹ Along with OASIS, iMMAP employs the Information Management System for Mine Action to manage the vast amount of humanitarian mine-action geospatial information collected in the field. The two systems work together to assist the Iraqi government and humanitarian organizations by creating the humanitarian mine-action common operating picture, allowing for humanitarian and response organizations to combine efforts in planning for overall security and general operations with a clearer understanding of contamination and security hazards. This provides a safer and more effective way to confront the challenges facing Iraq as a heavily contaminated country.

OASIS allows authorized users to enter and share data related to humanitarian mine action through custom interfaces.



Figure 2. Map depicting the type of security incidents stored in OASIS that have occurred over the past four years inside the Green Zone in Baghdad, Iraq.

Once the client posts or edits shareable information, the data is automatically synchronized via a central server, providing access to all OASIS users working in other regions that possess information-sharing capabilities. This increase in information-sharing is critical when assessing risks and dangers of humanitarian mine-action operations.

With user-friendly information tools for data-entry, analysis, mapping, reporting and data-sharing, OASIS breaks complex tasks into easy-to-understand steps using software that minimizes errors, reduces training requirements and encourages users to interact with the system.

OASIS provides organizations in the field with:

- Shared security-incident data
- Standardized reporting formats
- Evacuation-planning tools
- Personnel-accountability tools
- Location monitoring
- Easy-to-use analysis tools
- Mapping capabilities

Developed by the Center for Security Studies and Conflict Research at the Swiss Federal Institute of Technology in Zurich, Switzerland, on behalf of the Geneva International Centre for Humanitarian Demining and funded primarily by the Swiss government with assistance from other donors, IMSMA improves the safety, speed and efficiency of humanitarian mine-action activities. IMSMA also improves the operating environment for aid workers and deminers, as well as the beneficiaries they serve. The technology can be used to plan, manage, report and map the results of survey and field-data collections, as well as report and map clearance activities. IMSMA assists managers in tracking the progress of their work, in addition to analyzing and supporting prioritization decisions. National personnel who are trained and mentored by iMMAP maintain and operate IMSMA.

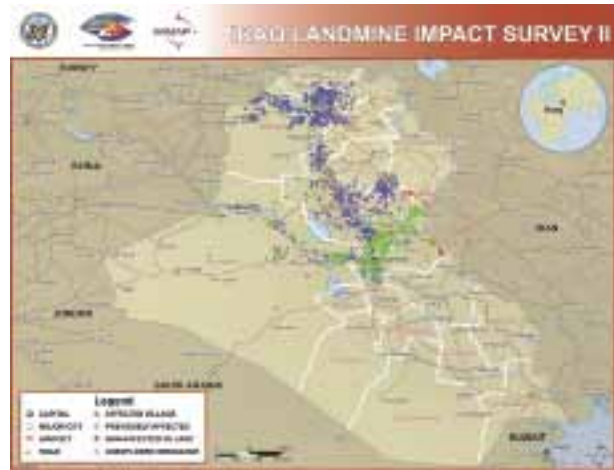


Figure 3. Map showing the results of an Iraq Landmine Survey II.

An overarching HMA common operating picture is only achieved through OASIS and IMSMA's integration. Along with a wider range of relief, development and reconstruction stakeholders operating in Iraq, the two tools facilitate **mainstreaming** of HMA data to support ongoing reconstruction activities. HMA data and management information will continue ensuring that national stakeholders can utilize the system for operational and strategic planning for the foreseeable future. Additionally, by integrating HMA information with the humanitarian common operating picture enabled by the OASIS system, a range of stakeholders engaged in relief, reconstruction and development activities in Iraq can more easily access HMA-contamination and operations information.

OASIS in Action

By streamlining advanced geo-processing tasks for operators and project managers, OASIS improves HMA's effectiveness and efficiency, which is conducted by putting the proprietary IMSMA software's data, along with other relevant mission-specific spatial data, in the hands of HMA actors at all levels. This enables users to assess the situation and plan for a safe and effective field operation without extensive software costs or needing staffed information offices.

Specifically, OASIS assists in properly identifying site locations. In order for sites to be divided into sections and overlaid with other datasets like imagery or elevations, clients use the system to bring together IMSMA datasets with other relevant datasets that are not always readily available in a standard format. This provides for enhanced support of on-site planning and implementation of the appropriate removal technique. Moreover, this allows users to view operational information in an open-source, geographic information-system environment.

The OASIS system provides HMA organizations with a means to find new contaminated sites for clearance. The orga-

nization can retrieve the updated IMSMA data from national mine-action authorities and load that data into OASIS. Users can then see open contaminated sites (suspected hazardous areas that have not been cleared or are in the clearance process) and address the feasibility of the site or any corresponding security concerns. Furthermore, OASIS assists in ensuring travel security by allowing users to view security incidents along the route, which can help travelers find the safest route and the safest time of day, or day of the week, to travel to a given location. With the most recorded security incidents in Iraq, the OASIS security database contains more than 100,000 incidents since it began keeping records in 2006. As a result, OASIS allows for an assortment of trend analyses to improve operational safety.

Iraq

Landmines and unexploded ordnance severely affect Iraq. The Directorate for Mine Action in Iraq estimates that landmines cover an area of 1,101 square kilometers (425 square miles), and UXO-contaminated areas cover an estimated 479 square kilometers (185 square miles). In addition, hundreds of cached and abandoned ordnance sites are believed to exist throughout the country, sites that not only pose an immediate humanitarian risk, but serve as a ready source of explosives for insurgents. Due to the intense security risks inherent to working in Iraq, developing a common operating picture of contamination and mitigation efforts is challenging. Every day, Iraq has more than 25 security incidents, ranging from improvised-explosive-device attacks to civil unrest; consequently, danger is a part of daily life for those traveling to and from its worksites. Humanitarian and reconstruction stakeholders were previously unable to reliably coordinate with Iraq's national and regional mine-action coordination centers. To address this need, iMMAP and Iraq's Directorate of Mine Action reconstituted Iraq's IMSMA capacity in 2007.

iMMAP now produces Iraq's overarching HMA plan by integrating IMSMA, OASIS and Landmine Impact Survey information. Furthermore, with the development of geospatial data, security incidents, gazetteers,² transportation networks and other datasets, iMMAP can overlay results and provide a more detailed understanding of landmine/UXO contamination.

By making HMA information simpler and more accessible to the relief-and-development community, iMMAP creates awareness for activities such as demining, explosive-ordnance disposal and mine-risk education. iMMAP also enables ERW reporting that would not typically be provided to relief-and-development implementers. iMMAP gathers and



A landmine survivor is fitted with a new prosthetic during a training session.
Photo courtesy of Dave Evans.

combines various reports using OASIS and other geospatial tools, ensuring that humanitarian and reconstruction activities are conducted safely in potentially contaminated areas.

All recent IMSMA data is made accessible through OASIS, providing users with timely and accurate information concerning ERW contamination as it becomes available. With the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) providing resources, iMMAP's HMA activities in Iraq obtain new and previously unreported landmine/UXO contamination data through the Landmine Impact Survey and other field-data collection efforts. These data are entered into the IMSMA records and integrated into the national operational and strategic-planning processes utilized by the Directorate for Mine Action, the Iraqi Kurdistan Mine Action Agency, and other Iraqi governmental entities and international re-

Congolese Soldiers Learn to Combat UXO and Mines

This article focuses on how U.S. Africa Command (U.S. AFRICOM) supports the Democratic Republic of the Congo in carrying out its mine-action objectives by providing train-the-trainer and supervisory services and mine-action equipment to the DRC.

by Staff Sergeant Amanda McCarty [U.S. AFRICOM]



Sergeant Ramazani Muhamadi, a Congolese military engineer with the 9th Region, instructs soldiers on proper wear of personal protective equipment during a three-week humanitarian mine-action training in Kisangani, DRC.

All photos courtesy of AFRICOM and the author.

“African solutions to African problems,” a motto for U.S. Africa Command engagement in Africa, stands as a reminder that helping African militaries self-sustain their operations is often just as important as the activity itself. Recent mine-action training in the Democratic Republic of the Congo provided an example of how U.S. AFRICOM incorporates sustainability into its activities with African partners. AFRICOM

teamed with Congolese Armed Forces soldiers as part of the command's humanitarian mine-action program to help re-establish a mine-action company at Camp Base in Kisangani, DRC.

In coordination with the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), the command began its mission to assist the DRC's *Forces Armées de la République*



Congolese soldiers use the buddy system to help each other put on their protective suits before heading into the mine-exercise field.

Démocratique du Congo after the country requested support in September 2009. AFRICOM conducted eight missions since then to build and train a company to conduct mine-action activities including identification, removal, destruction and protection against mines, unexploded ordnance and explosive remnants of war.

“The program has been a success,” says Jack Holly, U.S. AFRICOM’s HMA Branch Chief. “The command’s engagement with the FARDC Engineer Company has fostered a unique relationship instituting a viable program in demining, explosive ordnance disposal and explosive remnants of war operations.”

To develop a self-sustaining program, AFRICOM trained a select group of Congolese engineers as mine-action instructors; these Congolese instructors in turn train other Congolese soldiers. After years of conflicts in and around the country, this group is the first DRC national asset to be trained to support demining and ERW removal. During an

AFRICOM-supervised training mission in March 2011, the Congolese engineers conducted all the instruction. Verbal and hands-on training covered proper handling techniques, protective gear and safety use, identification and clearing/detonation of UXO and mines.

In addition to supervising the new Congolese mine-action trainers, AFRICOM provided equipment valued at US\$125,000 to use as training aids for demining and explosive-ordnance-removal instruction. Congolese soldiers teaching the course during this latest mission provided demonstrations on personal protective equipment, metal detectors, hand tools and other equipment.

Lieutenant Junior Grade Andrew Giacomucci from Mobile Unit 8, operating with Task Force 68, Naval Station Rota, Spain, led the 21-day training mission. “I have been impressed with what I have seen,” he says. Giacomucci adds that he thought the sustained mine-action training and involvement helped strengthen the bond between the U.S. and Congolese militaries.

“Partnering is essential to the success of this program; no one organization can do it alone,” Holly says. “We are partnering with the U.S. Department of State [PM/WRA], Handicap International—an international nongovernmental organization—and the United Nations Mine Action Centre and the DRC Center for Demining, both in Kinshasa.” PM/WRA provided support to AFRICOM via Handicap International in the form of a grant for \$15,775. This funding was used to purchase equipment that assisted AFRICOM’s training program. PM/WRA’s grant will support AFRICOM’s four training missions in 2011 and 2012, while also helping HI stay engaged in Kasai-Oriental province. Although Handicap International did not provide funding, they did contribute to the AFRICOM project in Kisangani with in-kind support in the form of training/awareness programs on humanitarian demining and the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on their Destruction’s* five pillars, as well as deconstruction components for explosives.

Contamination varies throughout DRC’s provinces; however, mine threats are believed to be significantly less than that of ERW. AFRICOM’s HMA training teaches identification and safe disposal of both. “Unexploded ordnance is the leading cause of injuries in Africa, surpassing that of landmines,” Holly points out.

Kisangani, located in the northeastern province of Orientale, has had significant problems with mines and UXO as a result of successive wars and conflicts during the last two decades. About the size of Spain, the province has a population of 5.5 million, and suspected landmine/UXO-contaminated land totals about 8 million square meters (1,977 acres). This area represents

more than half of the DRC’s remaining hazardous areas, making Kisangani a prime location for a mine-action company. The Congolese Minister of Defense has expressed his intent for Camp Base to become a national demining training center, capable of assisting the population and working with the United Nations Mine Action Coordination Center in Kinshasa to conduct other operations in-country.

“HMA demand in Africa, not only in the DRC, is growing, and more assistance is needed,” says Holly. U.S. AFRICOM also conducts HMA training with militaries in Burundi, Chad, Kenya, Mozambique and Namibia, and is expanding operations to Mauritania and Tanzania next year. “AFRICOM’s HMA program has expanded to the point that we’ve exceeded our capacity to sustain our current level of engagement,” Holly points out. “We won’t be able to expand into new areas without passing the planning and execution phases of the program to [U.S. AFRICOM’s] component commands.”¹

The goal of HMA activities—specifically in the DRC—is enabling and helping equip the Congolese with the skills and abilities to safely address their mine problems, something the AFRICOM HMA coordinator Jack Holly said the Congolese are well prepared for.

The final training with the mine-action company at Camp Base was completed 29 July 2011; however, Holly says this is not the end of AFRICOM’s engagement. “U.S. Africa Command’s HMA program will continue to support this important project into the future, promoting mine action, engagement and mentoring the FARDC HMA instructors.” ◊

See endnotes page 83



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Conflict in Libya and the Future Risk to the Demining Community

The evolving face of modern warfare in Libya and elsewhere will leave behind an explosives legacy that the humanitarian-demining community must manage. This article examines the innovation of the anti-government forces in employing modified weaponry and assesses some of the challenges this might bring to humanitarian demining and explosive-ordnance-disposal teams in the future.

by Adrian King [Allen-Vanguard Ltd.]

Since the beginning of Libya's armed conflict, the anti-government militia has desperately sought the means with which to counter the superior military capability of the better-trained and equipped pro-Gadhafi military forces. Arguably, much of the capability vacuum was filled to some extent by NATO's military intervention, which although providing a potent and significant air component on the side of the rebels, left anti-government forces disadvantaged, especially during the initial ground-fighting encounters.



57mm air-to-ground aircraft rocket pod prepared in a ground-to-ground role mounted on a vehicle with improvised launch platform.

All photos courtesy of the author.

Necessity Drives Innovation

"Necessity is the mother of invention," wrote Plato. This is a rather apt description of the anti-government forces' predicament at the outset of the conflict and might also be taken to mean "desperate situations often breed innovative solutions"; and in this, the anti-Gadhafi rebels have on occasion excelled. Their ideas were inspired by a glut of available ammunition and a chronic lack of the parent weapon systems from which to fire and launch it. While certainly innovative, however, the rebels have not always reflected on either the viability or the safety aspects of modifying or copying military weapon systems. Initially, the underlying necessity to experiment and develop improvised weapons was in part due to their possession



An anti-government militia prepares a homemade electric command-initiated firing pack constructed from domestic light switches in preparation to fire 122mm GRAD rockets from an improvised launcher in Benghazi, Libya on 19 April 2011.

of a very limited array of serviceable military vehicles and the personnel trained to operate them. This led to the wholesale modification of any suitable motor vehicle to withstand small-arms fire effects and allow the mounting of heavy weapons to provide the mobility of firepower and transport to the area of battle much needed at the time.

Improvisation is not entirely limited to vehicle-mounted weaponry; dismounted direct and indirect fire systems were also invented or modified. The apparent lack of mortar tubes and rocket-launch platforms, for example, encouraged a rampant garage industry in designing and building the required hardware. Necessity has driven this industry, and although many designs are practical under the circumstances, some will inevitably be proven unsafe and more of a hazard to the user than the intended target.

As anti-Ghadafi forces gained the ascendancy, a requirement developed to employ weapons with some degree of stand-off. This has led to a unique array of sometimes improbable constructions that—although not particularly effective in the majority of cases—gave some degree of capacity to fight entrenched forces occupying the towns and villages

unfortunate enough to be caught up in the conflict. The inaccuracy and rather random use of these weapons has probably had negligible tactical effect, especially in the early stages, but these factors will undoubtedly have contributed to the human cost of the rebellion.

Weapon Types Employed

Apart from explosive-remnants-of-war challenges normally anticipated following armed conflict, demining organizations in Libya will likely confront improvised weapons and explosive devices that are perhaps different from accepted explosive threats within the context of humanitarian-demining activity. Improvised explosive devices used by both sides of the Libyan conflict are now a likely escalation as the conflict develops with more asymmetric tactics. Although the rebels, fighting a superior enemy, may have gained more from IED employment at the outset, pro-Gadhafi forces will probably also use IEDs as their resistance continues while resolution is sought to end the conflict, and perhaps in the aftermath.



BMP-1 turret welded to a frame mounted on the back of a Toyota Hilux 4x4. This heavily improvised system was recorded firing the integral 73mm gun during the battle of Galaa/Soffit Hill, 07 June 2011.

Even at sea, examples of asymmetric tactics were employed as in the case of a high-explosives-laden, rigid-hulled boat with two mannequins on board that was used as a decoy to attack patrolling naval vessels off the port of

Misrata. The boat was fortunately detected and destroyed (and the explosives detonated) by gunfire, but under different circumstances this water-borne IED could have damaged or even sunk a military or commercial vessel. Although the means of initiation were never discovered, radio-signal detonation from shore was the most probable trigger mechanism for this device.

Tactical Warfare Shifts

Libya's situation is further evidence of the altering nature of modern conflicts and an indication of what the future holds. Conventional military might is confronting increasingly asymmetric tactics, where the ill-equipped and less-able force compensates for military weakness through the employment of improvised weapons and IEDs—tactical weapons with strategic effect. Certainly in Libya both combatant elements have innovated as military hardware is destroyed and conventional warfare tactics become less viable.

Preparedness of Demining Organizations

With humanitarian-demining personnel deploying to destabilized countries such as Libya, mine-action operations must reflect on and mitigate against the specific threats through their training regimes and operating procedures.

While planned demining activity will always be required, an increasing complexity also emerges to the explosive-ordnance-disposal aspects of demining operations where complex tasks are encountered more frequently because of changing warfare tactics that cause greater exposure to such threats. Demining organizations face a challenging future in Libya and elsewhere, and improvised weapons and IEDs—some of which will be devised locally while others will be copies from conflict areas such as



Explosives removed from a Belgian PRB-M3A1 anti-tank mine to be used in IED manufacturing.

Afghanistan, Iraq and perhaps Yemen—will undoubtedly have an effect on operations. With no on-the-ground Western military presence in Libya, demining organizations will face EOD burdens and challenges. Skill levels and operating procedures to meet the challenge must develop in order to mitigate the current and emerging explosive threats, and the greater exposure of personnel to IEDs, nonconventional explosive devices and weaponry. ◊



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Landmines in Libya

Landmines are an unfortunate part of Libya's past and present. As such, the author discusses the various types of mines that have been found so far, providing a technical overview of each. With his landmine analysis, King warns of the difficulties that lie ahead as deminers begin to address the problem.

by Colin King [Fenix-Insight Ltd.]

Until recently, the primary threat from mines in Libya originated from the Western Desert Campaigns of the Second World War (June 1940–February 1943) and a series of conflicts with Chad between 1978 and 1987. During the recent civil war, it emerged that Libya also has substantial landmine stockpiles, and that both anti-personnel and anti-tank mines had been laid during the hostilities. In addition to the common Cold War legacy weapons found in many countries, there have been some unexpected finds, including landmine types of which little was previously known.

What follows is a brief technical overview of the mines and mine threats recently found in Libya, including some of the questions raised by these findings.

Type 84

Perhaps the most significant recent find is the Chinese Type 84. For many years those working in demining knew about this rocket-dispensed scatterable munition (84 represents the approximate year of introduction), but there were no reports that the mine had ever been deployed and little technical detail was available. Suddenly, in May 2011, these mines were used against the port of Misrata, and for a time a number remained unexploded in the streets before they were cleared.

The Type 84 used in Libya differs slightly from those shown in Chinese sales literature, but key features remain, including a parachute, three folding prongs (designed to stick into the ground on impact) and electronic magnetic influence fuze. Initiation using magnetic influence is particularly significant to deminers since these fuzes can be highly sensitive to both the proximity of small magnetic objects and to movement. It is unknown whether this Type 84 variant incorporates a self-destruct feature but, if so, it has clearly failed in a number of cases. As the explosive-ordnance disposal community has learned over the years, this is hardly a surprise; so-called **back-up** fuzes not only fail with alarming regularity, but also provide another potential means of accidental initiation.



The Chinese Type 84 is a scatterable AT mine initiated by a magnetic influence fuze.

All photos courtesy of the author.

TAB-1

The TAB-1 is a Brazilian AP blast mine that has already been responsible for a number of casualties in Libya. It was also used in Ecuador and Peru, but little was known of its make-up until it was examined recently.

Although not a true minimum-metal mine, the metal content of the TAB-1 is low, with the only metallic components being the mild steel firing pin (0.36 g) and the aluminum detonator capsule (estimated at 0.15 g). The main charge is approximately 60 g of Pentolite (PETN/TNT mixture^{1, 2}). There is also a small booster pellet, which appears to be PETN, in the base of the fuze. The simple mechanical fuze screws into the central well of the mine body and is actuated by a pressure of approximately 20 kg. There is no safety or arming device. Also noteworthy is that the TAB-1 is used as the initiator for an AT mine (also designated TAB-1). The two tend to be supplied and used together; therefore, there is a distinct possibility that the AT mine may also be present in Libya.



The Brazilian TAB-1 is a low-metal AP mine, also used to initiate an AT mine of the same designation.



The M3A1 is a variant of the M3 which incorporates two auxiliary fuze wells.

Belgian M3 and M3A1

The most common mines in Libya appear to be the Belgian M3 and M3A1—around 250,000 are stockpiled in Benghazi alone. Although a relatively simple and basic AT mine, the M3 is notable for its minimal metallic content (which makes it very difficult to detect) and powerful 6 kg charge of TNT, RDX³ and aluminum.



The Belgian M3 is a minimum-metal mine with a powerful charge of TNT, RDX and aluminum.

Unlike the M3, the M3A1 incorporates two auxiliary fuze wells for booby trapping; one in the side and one in the base. This capability is particularly relevant given that compatible anti-handling devices have also been seen in Libya. Even more worrying is the prospect that, without the pressure-plate assembly fitted, either of these mines could be initiated by the weight of a person, thereby converting the AT mine into an oversized AP mine.

Type 72 SP

The Chinese Type 72 SP metallic AT mine was featured in numerous videos from Libya, with large stocks held in Benghazi and probably elsewhere. The Type 72 (one of several Chinese mines with this designation) is externally similar to the Russian TM-46, but uses a completely different fuze, which incorporates an effective blast-resistant mechanism. It also has a spring-loaded pressure plate to allow the fuze to reset after being subjected to overpressure.



The Chinese Type 72 SP AT mine, with blast-resistant fuze to the left.

Use of the SP suffix was previously unknown, and this is believed to refer to an export version for tropical use. In this variant, sand-colored paint had been sprayed over the olive green used on most Chinese mines; this is clearly visible around the internal voids and wells. There is a large auxiliary fuze well in the base for booby trapping, but there have been no sightings of the anti-handling devices used with this mine.



The Belgian NR 413 fragmentation mine can be initiated by any of four tripwires.



Sectioning a live NR 413 AP mine for examination.

Other Mines

Other mines present in Libya include the Belgian NR 413 stake mine and NR 442 bounding mine, both of which are AP fragmentation weapons with significant ranges.

The NR 442 is normally buried and uses a pressure fuze to initiate a propel-

lant charge; this fires the mine body out of the ground before detonation occurs at a height of about a meter. The mine contains 2,500 steel fragments that are lethal within 25 m but can cause injury or death at far greater ranges.

The NR 413 is normally mounted on a steel stake and initiated by any of four tripwires. At a time when the tripwire threat in most countries has virtually disappeared, clearance teams in Libya may once again be forced to adopt laborious and time-consuming tripwire search procedures in areas where this mine is suspected.

The NR 109 trip flare, also present in Libya, is easily confused with the NR 413. Despite the similarity of the fuze and body, the components of these two devices have different threads and are not interchangeable.

Two other mines, neither of which was previously associated with Libya, have also been found in Benghazi. Both the Yugoslav TMA-5 and the Czech PT Mi-Ba-III are minimum-metal AT blast mines that can be difficult to detect. These are large mines capable of immobilizing main battle tanks, and would completely destroy any civilian vehicle.

The PT Mi-Ba-III fuze incorporates a cocked striker, meaning that the mechanism is spring-loaded and therefore capable of functioning at any time. The plastic collar retaining the striker is vulnerable to deterioration in hot dry conditions, making this mine extremely dangerous to handle. This mine was believed to have been responsible for a number of casualties during the First Gulf War (1990–1991) and is definitely a blow-in-place item.

Conclusion

The mine threat in Libya could create a significant challenge for deminers, with a combination of unrecorded minefields, difficult detection, the

presence of tripwires and the potential deterioration of fuze mechanisms. Demining nongovernmental organizations have already begun clearance operations with the United Nations Mine Action Service Joint Mine Action Coordination Team, working to coordinate operations. In addition to the standard process of survey, minefield delineation and clearance, a major stockpile destruction program will also be needed.

Sadly, despite widespread adoption of the AP Mine Ban Convention,⁴ mines have once again played a role in modern conflict. They bring with them the dangerous, costly and laborious process of demining, along with the disheartening prospect of long-term socioeconomic impact on the communities where they are found.◊

See endnotes page 83



Colin King served 14 years in the British Army, mostly in explosive ordnance disposal, including operations in the Bosnia, Falklands, Gulf, and Kosovo; he also led the first British team to train Afghan deminers. He worked as a British EOD school instructor and an EOD intelligence analyst before his final tour with the Gurkhas and later starting his EOD consultancy. Recently, he has been involved in mine clearance on the Falkland Islands, studies into the effects of landmine aging and assistance to regional cluster-munition stockpile-destruction programs. King also writes two reference yearbooks, *Mines and Mine Clearance* and *Explosive Ordnance Disposal*, for Jane's Information Group. This article is based on King's brief visit to Libya in July 2011, where he disassembled and examined a selection of landmines.

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25 August 2021

This article has been temporarily removed. We apologize for any inconvenience.

Sincerely,
The Journal of CWD

Thailand and Compliance with the APMBC: Mission Impossible ... Or a Feasible Task?

This article addresses the mine-action challenges Thailand faces in maintaining compliance with the Anti-personnel Mine Ban Convention. Given the uncertainty of mine locations and the Thailand Mine Action Centre's limited capacity, the delegation of Thailand's mine-action resources can be an issue, as hazardous areas can be difficult to determine. The emergence of a new national land-release mine-action standard, however, means that Thailand's ability to efficiently identify hazardous areas will allow limited resources to be appropriately assigned to areas needing clearance.

by Håvard Bach [APOPO]

The Khmer Rouge claimed yet another victim in July 2011, this time in Thailand's Trat province near the Cambodian border. This recent incident stemmed from the legacy of fierce fighting played out between Khmer Rouge and Vietnamese forces on both sides of the Thai-Cambodian border in the 1980s. The war is finished, but casualties continue.

Fighting between the Khmer Rouge and the Vietnamese typically occurred on and around rocky hilltops and densely vegetated ridges, leaving grim conditions for survey and clearance. Most of Thailand's mine-suspected areas are heavily overgrown with large sections scarcely populated and rarely visited because of the risk of potential landmines and explosive remnants of war. During the war, front lines regularly

shifted, thus leaving a blurred picture of where mines may be located. While evidence of mines in many areas exists, other currently suspected areas have no real evidence of mines other than a general suspicion stemming from past warfare.

A Landmine Impact Survey was undertaken in Thailand from 2000 to 2001. More than 2,000 square kilometers (772 square miles) were enrolled in the TMAC database and misinterpreted as a real representation of the mine problem.¹ Subsequent efforts to resurvey these areas have resulted in the cancellation of almost 1,500 sq. km. (579 sq. mi.) of land. Today 540 sq. km. (208 sq. mi.) of land remains suspect.¹ Despite the good effort, Thailand cannot meet its APMBC deadlines without a radical change of direction and a structured approach to resolving the problem.

APOPO, a Belgian nongovernmental organization, partnered with a local Thai organization, Peace Road Organisation (later referred to in this article as APOPO-PRO), and developed a survey and land-release methodology for Thailand, which is being implemented in full cooperation with the Thailand Mine Action Centre, Thailand's military, Thai Civilian Deminer Association and Norwegian People's Aid. The process raises interesting questions related to how mine-affected states will comply with the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (also known as the Anti-personnel Mine Ban Convention or APMBC).

The newly endorsed system challenges a common perception of how to resolve a mine problem for convention compliance. By analyzing how European countries justify compliance with the APMBC, Thailand developed an approach that could enable full compliance within a reasonable timeframe, and breaches traditional belief that it would take more than 100 years to rid Thailand of landmines. Thailand's solution may be an example of how similar problems could be addressed in other countries.



A TM-62 M Anti-Vehicle Mine typical of anti-tank mines found in Thailand.
Photo courtesy of Colin King.

Thailand's Mine-action Capacity

The national mine-action capacity consists of four military Humanitarian Mine Action Units deployed along Thailand's borders. Additional capacities include the Technical Survey teams of the partnerships between NPA and the Thai Civilian Deminer Association and APOPO and Peace Road Organisation; both of these partnerships became operational in June 2011. A few other local organizations² exist, but they lie dormant due to a lack of funds. Each HMAU clears approximately 0.6 sq. km. (0.23 sq. mi.) of land on average per year. Less than 2.5 sq. km. (0.97 sq. mi.) is cleared annually, and a major part of the clearance capacity is occupied with percentage sampling of land that was cancelled through a desk assessment of old survey information. The policy was to sample 25 percent of cancelled land. Assuming that 200 sq. km.

(77 sq. mi.) of land is still cancellable, a 25 percent sampling requirement would require clearance of 50 sq. km. (19 sq. mi.) and occupy all of Thailand's clearance capacity for the next 20 years without clearing any of the confirmed-hazardous areas. TMAC is aware of the situation and is making every effort to restructure its own mine-action approach.

TMAC coordinates all HMAUs. Given the comparatively small size of the national capacity, Thailand's mine-action capacity must be used to clear proven, as opposed to perceived, minefields. Focusing on proven minefields was not past practice, and the HMAUs consequently find very few mines, but this does not imply that Thailand has few mines. On the contrary, APOPO-PRO found more than 140 anti-personnel mines, as well as one anti-tank mine and 168 ERW, during the first seven weeks of Non-technical and Technical Survey. Thailand (and many other countries) believes that areas that cannot be proven mine-free must be cleared or, as a minimum, released by considerable Technical Survey efforts. In Thailand this perception caused the use of scarce clearance resources in areas with little or no landmine evidence. Few mines were found and few minefields were cleared. Despite a fairly successful land cancellation process called the **Locating Minefield Procedure**, Thailand has never fully managed to dispose of the Landmine Impact Survey legacy. Clearance resources were used indiscriminately to clear suspected-hazardous areas as well as sample cancelled land. The real lifespans of the minefields are prolonged and as a result, accidents can occur.

APOPO's Survey Efforts

TMAC asked APOPO to conduct a Non-technical Survey of all mine-suspected areas along the Cambodian border starting in 2011 with the provinces of Chantaburi and Trat, and con-

Recent examples of mines discovered in Europe

- Four AP mines were found in Herdla, Norway in March 2003 according to the Norwegian press.
- In August 2009, Patrick Ligtenberg, a Dutch treasure hunter, found a landmine with his metal detector.
- On 3 May 2010 a landmine was found and destroyed at a Bulgarian beach.
- Sixty AP mines were found in Hattfjelldal, Norway in September 2010.
- On 5 October 2010, newspapers in Holland reported that 700 AP mines were found in Zeeland Cadzand.
- Three more mines were found in another part of Holland on 24 May 2011.
- In June 2011 the Norwegian Army issued a public warning to the civilian population in Kirkenes about making fires in a popular recreation area just outside Kirkenes town because of the ERW risk from World War II.
- On 7 July 2011 a landmine was found in Varsenare, Belgium.
- On 1 August 2011 five landmines were found in Quend, France.
- On 30 August 2011 a man found an SMI-35 AP mine in his garden in Breda, Holland.

tinuing with the remaining provinces in 2012. Preparations began in January 2011 and the survey was fully implemented in June 2011.

Before implementation APOPO and TMAC jointly developed the conceptual national framework for land release. National standards on survey and land release were developed, followed by a considerable outreach package. The latter included conducting two land-release workshops with key participants from TMAC, the four HMAUs, NPA and The Development Initiative. National survey and land release standards were reviewed and endorsed during the last workshop.

The New National Standard

The new national mine-action standard for land release was made to comply with International Mine Action Standards. It emphasizes the need for tight evidence-based Non-technical Survey of all mine-suspected areas in Thailand. The outcome of the survey will form a baseline for what Thailand needs to clear or release by additional survey to comply with the APMBC. The standard's overarching aim is to provide a useful framework for professional conduct of Non-technical and Technical Survey, and justification for safe and effective land cancellation and release. The Thai national standard explains the principles of land release and the conduct of Non-technical Survey and Technical Survey. It also provides standardized reporting formats for:

- Non-technical Survey
- Land-release completion (Non-technical Survey, Technical Survey and clearance)
- Land reclassification

Informative documents in the standard include an example of the APOPO-PRO Non-technical Survey scorecard and the accompanying Technical Survey ground-coverage card.

The Non-technical Survey scorecard is a Microsoft Excel spreadsheet where all possible sources and types of information are listed and given a generic value or score. The final score is the accumulated value for all individual scores, and is used to determine a degree of confidence in whether an area is mined or mine-free. The confidence level will form the basis for how much follow-on Technical Survey is required to declare an area mine-free after Non-technical Survey.

The ground-coverage card is similar to the Non-technical Survey scorecard. By assessing the quality of the assets at collecting information during Technical Survey, developing a generic ground-coverage card is possible. If manual mine clearance is the best method and has the highest probability of finding a mine, a flail is slightly less suitable and has a lower probability of indicating whether or not mines



APOPO-PRO Non-technical Survey field discussions in Trat province. Small inaccuracies in data recording will have a major impact on the result. Quality training and regular monitoring of survey teams are key survey components.

Photo courtesy of the author.

are present. The same result can be achieved with the flail as manual demining in Technical Survey by increasing the size of the area to be searched. The ground-coverage card will inform deminers how much more land needs clearance. All available assets will be assessed and given a generic value in the ground-coverage card.

Land Classification

TMAC, by cancelling 75 percent of SHAs from the LIS, has previously defined the remaining suspected areas as mine-fields, labeling them dangerous areas and treating them as confirmed- and defined-hazardous areas. However, a lack of mine evidence in one area does not imply evidence of mines in the remaining areas. In other words, just because some SHAs are cancelled does not mean that the remaining suspected areas are contaminated and must be released by Technical Survey and/or clearance.

Article 5 of the APMBC obliges States Parties to “make every effort to identify all areas under their jurisdiction or control in which anti-personnel mines are known or suspected to be emplaced.”¹ A Non-technical Survey should be considered a minimum of such effort, and it will thus act as a baseline for what must be addressed through Technical Survey and clearance (and sometimes more Non-technical Survey) “to destroy or ensure the destruction of all anti-personnel mines



Map of Thailand.
Courtesy of CIA Factbook.

not later than ten years after joining the treaty.”³ Failing to put into effect this Non-technical Survey distorted the scope of the mine problem in many countries and prevented an appropriate mine-action response to the problem. In Thailand, it has resulted in a lack of focus on the real problem. Few mines were cleared, and the lifespan of real mined areas was extended.

Relabeling all Suspect Land as SHA

IMAS calls for a detailed evidence-based Non-technical Survey as the minimum effort to create CHAs; only now is

this happening in Thailand. TMAC has consequently agreed to reclassify all currently suspected areas as SHAs. These areas are not a measurement of the scope of the problem but rather areas where a Non-technical Survey is needed. Thailand considers Non-technical Survey as the first step in complying with the APMBC—“to make every effort to identify all areas known or suspected as mined.”³

Time for Reflection

The principles of drawing CHAs and cancelling land through a Non-technical Survey are fairly well understood. However, flaws in the system puzzle operators, politicians and mine-action authorities. Operationally, these flaws magnify the mine problem, committing scarce resources to clear areas that are eventually proven mine free and leaving CHAs uncleared for decades. If a CHA can only be designated as such through evidence of mines being laid, what does this mean for areas that cannot be reached during the survey or areas with little or no information available about mines? These are typically large, scarcely inhabited or uninhabited areas that form part of a wider combat zone but with no evidence of mines related to any specific location. Some mines may be in these areas, but identifying their location is impossible. Should these areas be cleared, or does the APMBC deem it acceptable to leave mines in the ground for future clearance, enacting government restrictions for future land use? Should the area then maintain a classification as SHA or perhaps be cancelled? Leaving an area as a SHA implies more survey is required, which is not possible in the foreseeable future. Cancelling land requires a fair certainty that no mines exist; most specialists would hesitate to cancel such land. When survey detail is lacking, these areas are more often enrolled in databases as CHAs (other terminology may be used, but the meaning is the same).

While statements like **impact-free** and **mine-safe** contradict the APMBC and could be seen as a shortcut to compliance, governments and operators in particular are looking for more efficient ways to release land and clear real minefields. They understand that by committing resources wrongly, the lifespan of the real, mined areas is prolonged significantly. Risk to local populations is proportional to the length of time these mined areas remain active. Local people will start to use mined areas if they are not cleared. More accidents will thus occur than if real mined areas (CHAs) are cleared more swiftly.

Proactive Versus Reactive Response

Compliance with the APMBC requires a reasonable effort to identify the scope of the problem and subsequently remove all mined areas identified during this process. As this

Confirmed-hazardous areas should not be created due to indefinite fear of mines stemming from past warfare or from a lack of proof that areas are actually mine-free. Such fear is rather a pointer for investigation of real evidence. CHAs should also not be created due to a lack of access to distant areas or a lack of information/informants in uninhabited areas. Only real mine evidence coupled with a war-tactical assessment justifies the creation of a CHA.

is required for APMBBC compliance, we call this a proactive response. The convention further commits signatories to respond swiftly and remove mines if they are found later. We may call this a reactive-response requirement. It requires a stand-by capacity that can swiftly remove mines not identified during the process of proactive clearance.

To explain this further, we may look to Europe. Many European countries had problems with mines after World War II. The proactive response could be defined as **survey land and clear all known mined areas**. In Norway, this resulted in some 750,000 landmines cleared in four years. Other European countries had similar responses, and millions of mines were found and destroyed. Despite most of the mine problem being resolved by 1949, a proactive survey and clearance response was maintained well into the 1960s in a few areas. Beyond 1949, most countries moved from a proactive to a reactive response and actively stopped looking for mines in favor of reactive stand-by (military) capacities. This process is ongoing today. Mines are still found from time to time in Belgium, France, Germany, Holland, Norway, Spain and the United Kingdom.

European countries nevertheless consider that they have made every effort to identify mined areas through survey and remove all known mines through clearance. A small residual risk of mines remains, but revitalizing a proactive response is considered unreasonable. One way Europe deals with this small but constant residual risk is by restricting land use. Re-

strictions may materialize as special clearance requirements on new construction sites or as restrictions on general land use. Using fire is prohibited or restricted in some areas. Common agreement exists on the soundness of this policy, which results in very few accidents over time. However, this approach must not be confused with the situation in the Falkland Islands, for example, or the beaches in Skallingen in Denmark. Mines in these areas are known to be in specific locations and should thus be cleared during the proactive-response phase.

Assessing Europe's experience is useful when attempting to ensure other nations' compliance with the APMBBC. Such an assessment shows that convention compliance is a two-stage process of proactive and reactive response; it should form the basis for understanding how countries may address their own problems more effectively while complying with the convention. Mines remain in Europe, but the proactive effort to remove them has finished and the reactive effort continues. Finding the remaining mines through survey is unreasonable and impossible because they could be anywhere within larger, typically uninhabited areas. Clearing these areas would require enormous resources, and we would all agree that Europe's reactive response is not only appropriate, but it also complies with the convention.

APOPO-PRO's Non-technical Survey in Thailand

Expert group. An expert group consisting of experienced staff from TMAC, HMAU and APOPO-PRO was

TMAC's **Area With Restrictions** report explains **area with restrictions** as: "when all reasonable effort has been made to conduct a Non-technical Survey in an area (typically a SHA) but a lack of access to the area or shortage of information/informants has prevented conclusive cancellation of land or the creation of CHAs. AWRs are typically scarcely inhabited or uninhabited areas (forest, mountain areas, long-term flooded areas/dams etc.) where there is no concrete evidence of mines related to any specific part of the wider area. The residual risk of mines is deemed small, which justifies a shift from a proactive mine-action effort to a reactive mine-action response if mines should occur later."⁴

When survey organizations fill in the national **Area With Restrictions** form they are obliged make the statement: "We have made all reasonable efforts to survey the area through the conduct of evidence-based Non-technical Survey. The survey was inconclusive because of either a lack of access or shortage of information/informants. We found no evidence of mines in specific parts of the area. Since the survey was inconclusive, we request the area to be reclassified as Area With Restrictions. Type and level of restriction should be determined by TMAC in collaboration with local authorities."

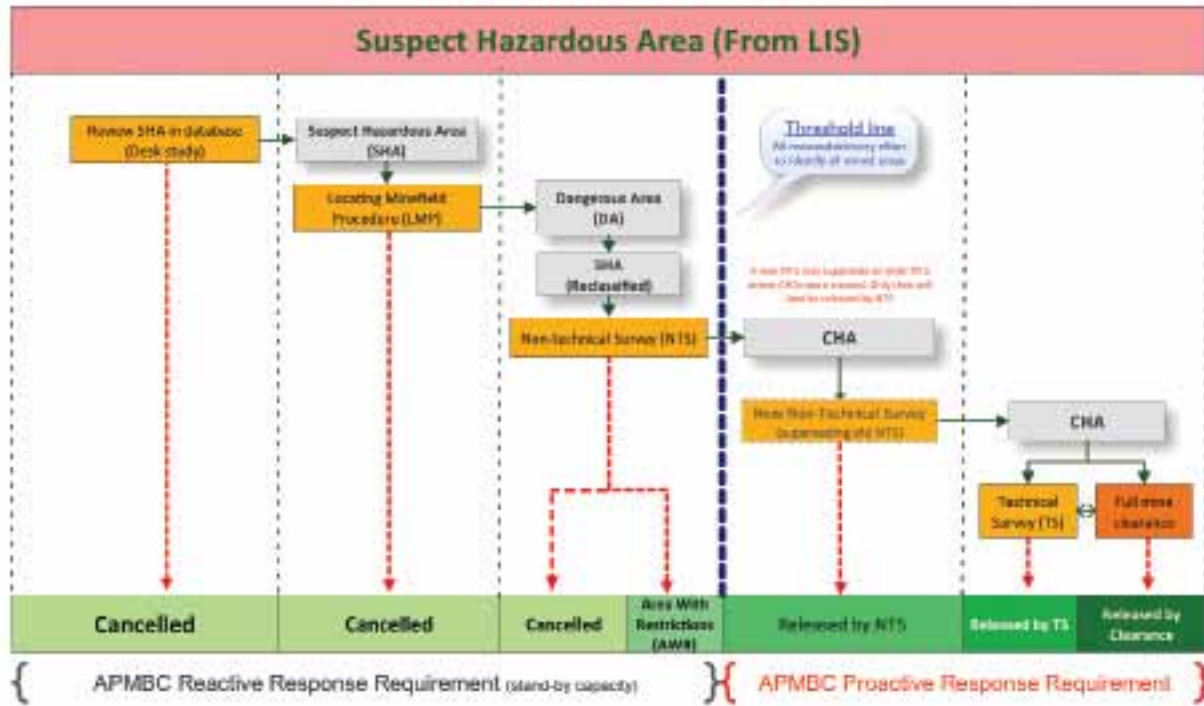


Figure 1. Diagram illustrating the process of resolving Thailand's mine problem. The blue line indicates the current status. Graphic courtesy of the author/CISR.

initially established to score the value of individual evidence. A scorecard incorporating every useful piece of potential Non-technical Survey information was developed with a scoring value for each piece of information.

Affinity between the Non-technical Survey and the Technical Survey. The Non-technical Survey will define the minimum requirements for follow-on Technical Survey before land can be released. When sectors are scored differently within the same CHA, this may justify a graded Technical Survey response. Most previous surveys failed to quantify affinity between the Non-technical Survey and Technical Survey for a tailored and more efficient Technical Survey response.

Drawing polygons. The survey teams were trained to draw tight CHA polygons based on an assessment of evidence coupled with a war-tactical assessment.

Sector division of CHAs. Following drawing of tight polygons, there may be scope to subdivide the CHA into smaller sectors. This is based on various degrees of evidence in different parts of the CHA (regarding the presence or absence of mines). Each sector will state whether mines are present or not. The amount and quality of evidence from the survey will generate a degree of confidence in these statements.

Mines versus unexploded ordnance. Evidence of explosions or unexploded ordnance is not the same as mine evi-

dence. The survey concept distinguishes consciously between mine and UXO evidence. The latter is not covered by the APMBC and will be reported separately.

Technical Survey. A Technical Survey component was established for selective deployment into areas where a tactical assessment provides multiple options or reasons for placing mines during the war. The component does not aim to conduct full Technical Survey, where the aim is to define the exact boundaries of mined areas or to release land. APOPO-PRO's Technical Survey capacity reinforces the Non-technical Survey, where needed, to justify tighter CHA polygons. The Non-technical Survey component (two manual-demining teams) is thus considered part of the Non-technical Survey and will help determine CHA and/or cancel land.

Land classification. Following the Non-technical Survey, land will be classified as a CHA, cancelled area or area with restrictions. This last classification will only occur in cases where all reasonable effort is made to conduct evidence-based Non-technical Survey, but the survey failed to conclude because of a lack of evidence or access to land. A precondition for drawing an area with restrictions is that there is no evidence of mines in specific parts of a larger area. If real mine evidence exists, a CHA will be created around it. TMAC will define type and level of restriction

on a case-by-case basis in consultation with local authorities. An area with restrictions will not be created based on an assessed low impact.


Follow-on Technical Survey. A follow-on Technical Survey concept was developed in collaboration with TMAC. APOPO-PRO's role is not to conduct full Technical Survey at this stage; instead the HMAUs were partially trained to do it. APOPO-PRO will likely start conducting follow-on Technical Survey and clearance in 2012. The Technical Survey concept follows the logical framework of the Non-technical Survey and complements the decision-making process to release land by measuring degrees of confidence in areas being mine-free.

It is too early to predict the final outcome of the survey. Preliminary results from one month of fieldwork, however, indicate that between 10 and 20 percent of suspect land (now reclassified as SHA) will be classified as CHA from the survey. The situation could be different in other places along the border, and the final outcome may or may not be an improvement. The remaining land will be reclassified as either cancelled areas or area with restrictions. TMAC and APOPO-PRO developed appropriate forms for separate reporting of CHA, cancelled areas and area with restrictions.

If we assume that the APOPO-PRO survey will result in 10 percent of suspect land being classified as CHA, Thailand will need to address 54 sq. km. (20.8 sq. mi.) of suspected-hazardous land proactively to reach its ultimate goal as a **mine-free** state. Thailand will further need to maintain an effective reactive-response capacity for APMBC compliance. If we further assume that Technical Survey and/or clearance assets will be needed on 60 percent of this ground, assets will be used to cover ap-

proximately 30 sq. km. (11.6 sq. mi.) of land. With eight years left of the convention extension, Thailand's national and international capacity needs to be big enough to cover 4 sq. km. (1.5 sq. mi.) of land per year. This is almost twice the size of the current clearance capacity—a challenging but indeed tangible task.

Conclusion

With proper identification, marking and use of clear terminology, the incident in the Khmer Rouge in July could have been avoided. In hindsight, Thailand's new land-release approach could drastically shorten the lifespan of the remaining minefields and boost the number of cleared mines. Mines will claim fewer victims, and full APMBC compliance is not beyond the realm of possibility. 

See endnotes page 83



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Pathways to Resilience Workshop Promotes Leadership and Peer Support

Pathways to Resilience (P2R) created a unique leadership program to help landmine survivors promote resilience and create secure collegial relationships. This article provides background regarding the curriculum and training activities and recounts how P2R helped survivors experience post-traumatic growth after tragedy.

by Anne Stewart, Ph.D., and Lennie Echterling, Ph.D. [JMU Dept. of Psychology], Cameron Macauley, MPH, and Nicole Neitzey [JMU Center for International Stabilization and Recovery], and Hasan Hamdan, Ph.D. [JMU Dept. of Mathematics and Statistics]



Pathways to Resilience attendees participated in a variety of creative activities designed to promote positive crisis resolution.
All photos courtesy of CISR.

A young woman flashed a bright smile and gracefully performed a traditional dance. The other women in the room responded with delight and encouragement.

A man announced to the people gathered that he had gone to town to purchase short-sleeved shirts to wear. His pronouncement was welcomed with spontaneous, heartfelt applause.

An accomplished country leader proudly introduced his younger colleague to conduct the final presentation. Each graciously acknowledged the support they have offered each other in troubled times.

These seemingly unremarkable events occurred during a mine-action training program conducted in the countryside north of Beirut, Lebanon.

The events, however, actually constitute remarkable milestones for participants attending this innovative workshop. The dance was the first the young woman had performed since a landmine explosion injured her while dancing at a relative's wedding. The man had not worn short sleeves since a mine injury resulted in the loss of his forearm. The junior colleague, a landmine-injury survivor, delivered his inaugural professional presentation.

Pathways to Resilience is an inventive regional training program developed and implemented under the sponsorship of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), and through partnership with the Lebanon Mine Action Center. The project was the vision of Kamel Sa'adi, a Jordanian landmine survivor who established a nongovernmental organization, Lifeline for Consultancy and Rehabilitation, to assist and support other survivors. Staff from the Center for International Stabilization and Recovery, Program Manager Nicole Neitzey and Peer-Support Specialist Cameron Macauley, coordinated P2R's planning and implementation. Faculty from the Departments

of Graduate Psychology and Mathematics and Statistics at James Madison University participated in the program to provide training, curriculum development, program evaluation, needs assessments and follow-up surveys.

The program took place in Beirut for landmine survivors from different landmine-contaminated regions of the Middle East, as well as representatives of organizations that assist these survivors. Twenty-nine participants from Iraq, Jordan, Lebanon and Yemen came to learn how to conduct peer-to-peer projects for survivors in their own countries. The intensive schedule involved experiential learning, theater-based activities, role-playing activities, improvisations and other exercises designed to promote post-traumatic growth. Within a culturally responsive framework, the leadership training addressed disability rights and laws, peer-to-peer support, post-traumatic growth and program-development skills for landmine survivors.

Disability Rights and Laws

Work with survivors of landmine injuries requires a human-rights perspective. Persons with injuries from war-related violence are not incompetent individuals requiring charity. Rather, they are persons entitled to full participation and inclusion in society. Participants were provided an overview of the historical and current context of the United Nations' *Convention on the Rights of Persons with Disabilities*, and other relevant regional and global initiatives, including the Cluster Munitions Coalition and the meeting of States Parties to the *Convention of Cluster Munitions* in Beirut (September 2011). The presenter discussed the definition of terms, the status of states as signatories or ratifiers, as well as the role of the CRPD in calling for nondiscrimination and access for persons with disabilities. The workshop participants discussed the importance of recognizing persons with disabilities as a valuable part of human diversity.

Peer-to-peer Support

Consistent with the workshop's experiential and collaborative approach, the format of the peer-to-peer support training included presentations, group discussions and practice sessions. The training activities were grounded in key theoretical literature in transformative and experiential learning in which the learning process begins with a concrete experience and is followed by reflective observation, conceptualization and active experimentation.

The workshop participants began identifying actions they considered helpful (visiting and listening to the survivor, helping the survivor make decisions about the future) and not



Participants engage in role-playing practice in small groups to improve their peer-to-peer support skills.

helpful (pitying, ignoring, doing too many things for the survivor) as they healed from their injury. This identification led to a discussion of the use of peer-to-peer support as a natural process where survivors of a traumatic experience are ideal resources for helping other survivors. Participants explored what defines a **peer**, discussing the relevance of comparable experiences, injuries, gender and age for successful peer-to-peer support. The participants concluded that similarity is only part of the equation, and what is most important is the relationship between peer-support worker and survivor.

Participants were introduced to peer-to-peer support worker skills, such as listening, understanding and validating the survivor's story, along with looking for strengths of the survivor and resources available. The participants engaged in role-playing practice in small groups with facilitators to develop their skills.

Based on resilience and attachment theories, the participants practiced asking **Getting Through** questions, such as "Who was especially helpful in supporting you to do that?" or "What did you draw from inside yourself to make it through that?" They also practiced asking **Making Meaning** questions, such as "As you make more sense of this, what have you learned so far?" or "What advice would you give somebody else?"

Participants learned ways to effectively use and combine individual and group formats of peer-to-peer work. The curriculum also examined funding challenges and how to manage peer-to-peer programs.

Post-traumatic Growth

Traditional trauma perspectives have focused on the deficits and disorders of survivors. However, recent research findings on resilience and attachment have exciting implications

for mine-action programs. While acknowledging a trauma's impact, the P2R activities also emphasized personal strengths and increased feelings of resolve. As a consequence, most survivors experience post-traumatic growth, reflected in enhanced psychological well-being, deeper appreciation for life and more meaningful relationships.

The personal growth and peer-to-peer activities focused on building secure relationships between survivors and the four main factors promoting resilience: developing social support, attributing meaning to the experience, regulating emotions and learning successful coping skills. Importantly, the program created a transitional community to promote resilience so that survivors could apply these principles to themselves in addressing the consequences of war-related violence.

Immediately after a traumatic event, survivors are likely to experience a crisis of meaning. The participants learned that survivors tell their stories to give form to this painful experience, to gain some sense of cognitive mastery and to make important discoveries about possible resolutions. The program leaders discussed and guided participant survivors to tell their stories in a variety of ways such as talking, playing, drawing,

sculpting, singing and writing. Through experiential learning, participants discovered that whatever form their stories take, the process helped them identify meaning from the catastrophic event.

Workshop participants learned ways to acknowledge the negative impact of the trauma and to simultaneously recognize the survivor through respectful and engaging interviews and activities. An activity called *Out of the Ashes* gave participants practice in how to help other survivors envision new possibilities in their lives. The activity was designed to help survivors explore achievements they have already accomplished, gain a sense of direction and hope, and increase their momentum toward post-traumatic growth.

The *Out of the Ashes* activity began by asking participants to write down or draw on paper a crisis event that they experienced. Then they burned the slip of paper and rolled the ashes in a piece of modeling clay. Using what they have learned and discovered in dealing with their crisis so far, the survivor then molded a symbol of hope from the ashes and the clay. At the workshop, all the participants moved from table to table to view each other's artwork and to hear, not about the traumatic event, but about the person's future hopes.

At least temporarily, trauma robs survivors of their dreams for the future. By using a resilience-focused approach, peer-support workers practiced ways to help other survivors envision new life possibilities. By drawing attention to these instances of dealing with challenges, survivors are given opportunities to discover unknown strengths, appreciate unrecognized resources and achieve a sense of hope.

Workshop participants learned that landmine survivors not only tell their stories, but the themes that emerge from these stories shape their personal identity. In other words, the narratives that survivors create do more than organize their life experiences: They affirm fundamental beliefs, guide important decisions, and offer consolation and solace in times of tragedy. Peer-to-peer support workers can help other survivors transform their crisis narratives into survival stories. In the experiential activities, the participants practiced offering comments and questions to facilitate a successful resolution to a particular crisis. The resilience lens served as a reminder to look for strengths, rather than focus on deficits, when working with landmine survivors. Participants also heard about the impact of trauma on the brain and how emotional regulation is disrupted after



Playwright and Actor Ghannam S. Ghannam worked with participants all week to create a theatrical presentation derived from the survivors' own stories. Dealing with themes of adversity and resilience, the play was performed on the closing day for media and distinguished guests in attendance.

a trauma. Using experiential and playful activities, participants practiced ways to help survivors reduce their distress, soothe themselves when upset and enhance positive feelings of resolve.

Exploring dimensions of resilience, building secure relationships and developing a transitional community was further facilitated by the survivors' participation in a series of experiential, expressive exercises (original movement, voice and story activities). These creative activities provided an opportunity for survivors to join in the production and performance of a play. The dramatic and theatrical presentation originated from survivor stories. (Ghannam S. Ghannam, playwright and actor, conducted this portion of the workshop based on a curriculum he developed entitled "The Seven Mirrors.")

Trauma is a time of intense emotions, but a common assumption is that individuals in crisis have only negative feelings, such as fear, shock and grief. Participants were informed about recent research that demonstrated survivors actually experience not only painful crisis reactions but also feelings of resolve. These feelings include courage, compassion, hope, peace and joy. Acknowledging and giving expression to the gamut of emotions, both negative and positive, can promote a positive crisis resolution.

Group Project Development

Another group project also addressed leadership and teamwork skills. The participants were grouped by country and given the assignment of developing a plan for a project in their home country. The projects were to incorporate elements of emotional, psychological and practical support to survivors of landmine/unexploded ordnance injuries and/or their families. Participants were told that they may wish to work on matters related to health, education, mobility or accessibility, human rights, employment or income generation, sports, or other survivor issues.

Staff and facilitators helped participant groups develop their project plans by considering the goals and objectives, logistics, funding, personnel, legal restrictions, and desired results. At the end of the week, the groups presented their ideas. Participants created projects related to rights, accessibility and sports programs in this useful learning exercise. The project sites were community-based and addressed survivors across the lifespan.

Follow-up surveys are polling participants on their use of the knowledge and skills they gained in the project-development exercise. The program created a blog and website where photos and comments can be posted to help preserve the relationships and connections.




Feedback from participants was overwhelmingly positive. One participant said about the workshop, "You cannot imagine how helpful this workshop is to get us beyond our crisis."

Evaluation Results and Conclusion

The feedback from participants was overwhelmingly positive. For example, 96 percent reported that they learned more about leadership, and 96 percent agreed that they had learned new ways to meet survivors' needs. Sample comments included, "The activities were excellent—they improved our morale and strength to give peer support," "One of the best, if not the best, workshops on VA [victim assistance] (and there have been a lot!)," and "You cannot imagine how helpful this workshop is to get us beyond our crisis."

More significantly, the majority of participants also reported their experience of post-traumatic growth. As a result of the workshop, 96 percent stated they had a greater feeling of self-reliance, 92 percent reported they had a greater sense of closeness to others and 88 percent discovered they were stronger than they thought.

In conclusion, P2R is a culturally-sensitive program that enhances the potential of landmine survivors for leadership in offering peer-to-peer support services to others. The attachment-grounded, resilience-focused and strength-based program can be easily adapted to other cultures. With this positive feedback, P2R plans to assist other countries and expand its use to additional victim assistance programs.

For additional information about the project, see <http://ciser.jmu.edu/P2R/index.htm>. 

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RESEARCH & DEVELOPMENT

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Metal Detector Pinpointing Accuracy Under Field Conditions

As ordnance and landmine-detection technology advances, mine-action organizations across the world are increasingly using more sophisticated types of metal detectors. Each metal detector contains its own strengths and weaknesses, and until now, no accurate way exists to quantify the differences between the models. In this article, a method is shown to successfully evaluate metal-detector accuracy in a controlled field condition and provides data on the differences between single coil, double-D coil and other metal-detector types. The International Test and Evaluation Program for Humanitarian Demining conducted the 2009 evaluation in Germany that provides the data used in this article.¹

by Kazunori Takahashi [Leibniz Institute for Applied Geophysics]

Metal detectors are commonly used to detect landmines and metal pieces during clearance operations. Because of the dangerous nature of clearance, metal detectors must accurately pinpoint targets to make excavations and removal as safe and precise as possible. Therefore, detection probability and location-accuracy performance must be tested to ensure proper performance. Previously, tests such as the Systematic Test & Evaluation of Metal Detectors Laboratory Test by the Joint Research Centre, European Commission² evaluated these criteria. In the field, however, an operator does not know if or where a target exists, and the accuracy will differ from laboratory tests.³ Subsequently, in the test described here, the purpose was finding a specific target in order to understand the detector's accuracy, not simply discovering if a target existed.

Pinpointing Error and Analysis

A target is located at a position (x_0, y_0) and is detected at (x_0', y_0') as shown in Figure 1 (below). The pinpointing error is the distance between the true and detected positions which is calculated as noted in Equation 1 (below).

$$d = \sqrt{\Delta x^2 + \Delta y^2} = \sqrt{(x_0' - x_0)^2 + (y_0' - y_0)^2}$$

Equation 1.

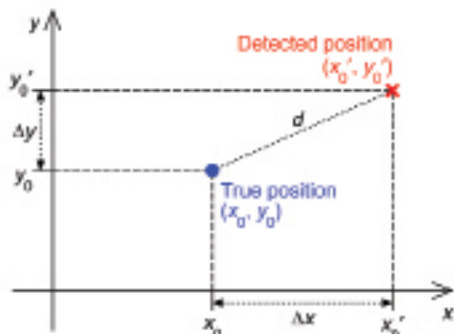


Figure 1: Schematic illustration for calculating the location error.

Assuming that the location errors in x and y (Δx and Δy) are uncorrelated and normally distributed, the location error d is characterized by a Rayleigh distribution whose probability density function is given as shown in Equation 2 (below).

$$f(d; \sigma) = \frac{d}{\sigma^2} \exp\left(-\frac{d^2}{2\sigma^2}\right)$$

Equation 2.



Objects used in the test. From left to right: metal clutter (ammunition belts, cartridges, bullets) and mine-like targets (Gyata-64, PPM-2, ERA calibration target).

Photo courtesy of BWB.

The parameter σ denotes the mode of distribution, which exhibits the location error that most frequently occurred. By estimating the parameter, the pinpoint accuracy of metal detectors can be evaluated. Note that in this article the word **mode** is used only for the statistical term mode, which indicates a random variable that happens most frequently (i.e., random variable where the histogram or probability function is the highest). The word mode is also commonly used to describe the way metal detectors work: static or dynamic. This use of the word mode is referred to as either **static mode** or **dynamic mode**³ in this article.

Data Analysis

The above-mentioned analysis was applied to the data obtained in the ITEP 2009 test.¹ The tested detectors are listed in Table 1 (next page). In the test, several types of targets were used. The burial locations of all targets were measured at the center of outer casings with the expected accuracy of 1–2 cm. Targets containing multiple metal parts, or holding a metal part off the center, were not tested, as they could skew results and were not suitable for these tests. Targets used in the analysis include only bullets and calibration targets containing a relatively small metal piece at a known location.

(Continued on page 66)

| Detector model | Working principle | Working mode | Search head shape | Search head size* | Remarks |
|----------------|-------------------|--------------------|------------------------|-------------------|-------------------------------|
| Vallon VMH3CS | Pulse | Dynamic | Oval | 17 x 31 cm | Static mode while pinpointing |
| Vallon VMC1 | Pulse | Dynamic | Oval | 14 x 33 cm | Static mode while pinpointing |
| CEIA MIL-D1 | CW | Static/ dynamic | Circular (double-D) | Φ 28 cm | |
| Ebinger 422GC | Pulse | Static/ dynamic | Circular | Φ 23 cm | |
| Minelab F3S | Pulse | Dynamic | Circular | Φ 20 cm | |

* It is the size of a search head and it can be larger than the actual coil size.

Table 1: Detectors tested in the ITEP 2009 test. The technical data were compiled from the Geneva International Centre for Humanitarian Demining detector catalogue⁴ 2009 and the Ebinger⁵ website.

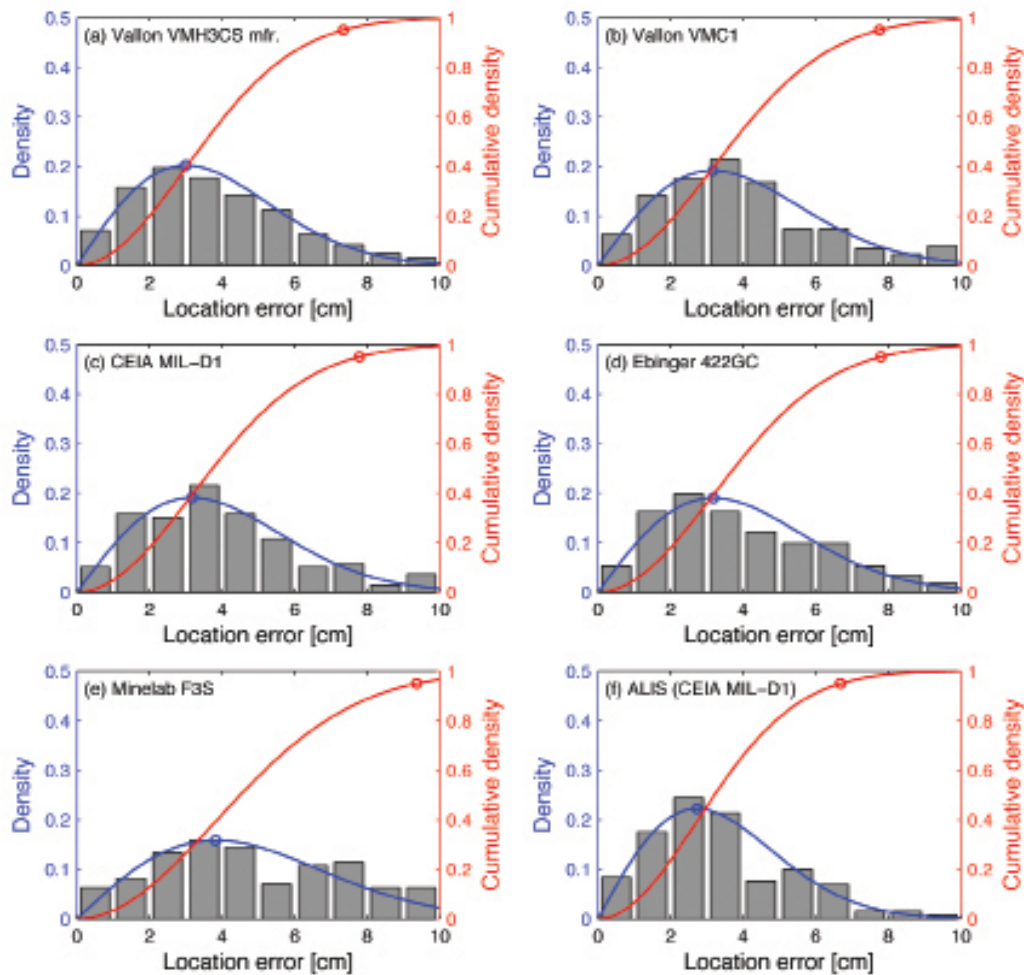


Figure 2. Examples of the location-error distributions calculated for (a) Vallon VMH3CS, (b) Vallon VMC1, (c) CEIA MIL-D1, (d) Ebinger 422GC, (e) Minelab F3S and (f) Advanced Landmine Detection System. The histograms show the actual occurrences of the location error. The blue curves and circles show the modeled probability density functions of the location errors and its mode that indicates the most frequently occurred location error. The red curves and circles show the modeled cumulative density functions of the location errors and 95th percentile indicating the location errors that include 95% of detections.

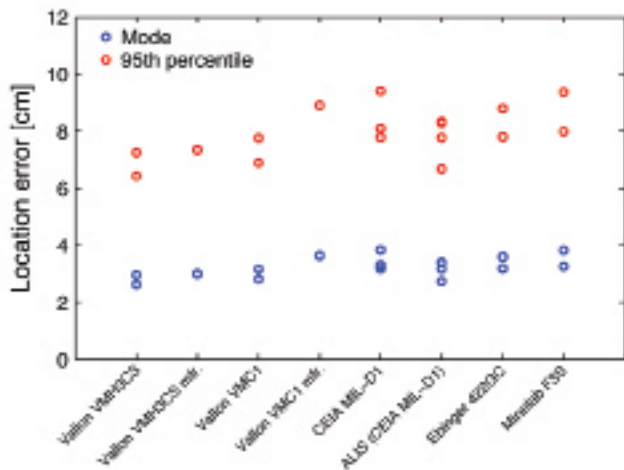


Figure 3. Mode (blue circles) and 95th percentile (red circles) of location error for each metal-detector model and operator. A lower location error shows a more accurate pinpointing.

| Detector Model | Mode [cm] | 95th Percentile [cm] | Detections within 5 cm radius [%] |
|--------------------|-----------|----------------------|-----------------------------------|
| Vallon VMH3CS | 2.8 | 6.8 | 80 |
| Vallon VMH3CS mfr. | 3.0 | 7.3 | 75 |
| Vallon VMC1 | 3.0 | 7.3 | 75 |
| Vallon VMC1 mfr. | 3.6 | 8.9 | 61 |
| CEIA MIL-D1 | 3.4 | 8.4 | 65 |
| ALIS (CEIA MIL-D1) | 3.2 | 7.8 | 71 |
| Ebinger 422GC | 3.4 | 8.3 | 66 |
| Minelab F30 | 3.5 | 8.7 | 63 |

Table 2. Location errors as mode (error that most frequently occurred), 95th percentile (error that includes 95% of detections) and percentage of detections that fall within 5-cm radius, obtained from the data of the ITEP Test 2009. The results were averaged over different operators for each metal detector model. The label "mfr." means being operated by personnel from the manufacturer.

All the detectors with various metal-detector models were observed and the location errors d were calculated for detections that were within 10 cm from the selected targets. Figure 2 (page 65) shows the histogram of the location error d for each metal-detector model. From the histograms with N random variables, the parameter σ in Equation 2 (page 64) was estimated by the maximum likelihood estimate given as Equation 3 (below).

$$\hat{\sigma} = \sqrt{\frac{1}{2N} \sum_{i=1}^N d_i^2}$$

Equation 3.

In Figure 2 (page 65), the modeled Rayleigh probability density functions are plotted with blue curves, and the estimated modes $\hat{\sigma}$ are plotted with blue dots. The curves were well fitted to the histograms. Further, the cumulative density functions were also calculated as Equation 4 (below).

$$F(d; \sigma) = 1 - \exp\left(\frac{-d^2}{2\sigma^2}\right)$$

Equation 4.

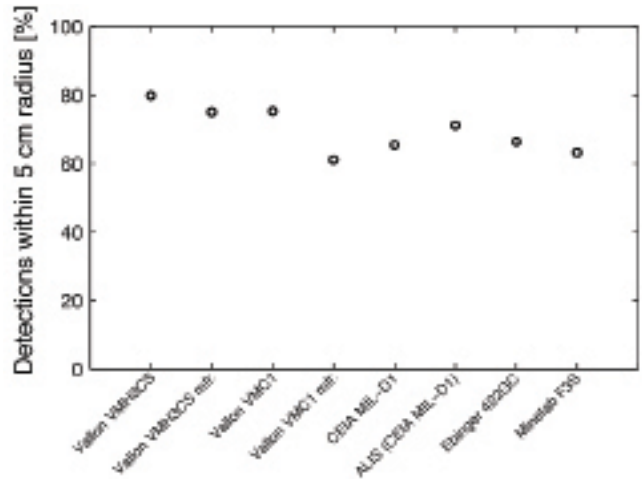


Figure 4. Percentage of detections that fall within 5cm radius. A higher percentage shows a more accurate pinpointing.



Figure 5. Pinpointing a target with (a) single-receive-coil detectors and (b) double-D coil detectors (reproduced from the STEM D Lab Test report and Metal Detector Handbook).^{2,3}

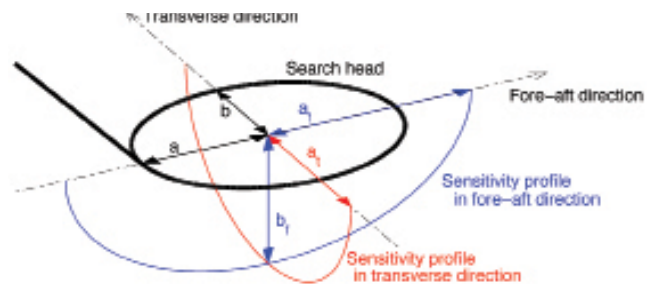


Figure 6. Schematic illustration of a metal-detector search head and its sensitivity profile. A circular coil detector has axes $a = b$, thus the axes of the sensitivity profile ellipses in the fore-aft, and transverse directions are assumed to be the same (i.e., $a_t = a_f$). For an oval-shaped coil detector, the ratio of the sensitivity-profile widths is assumed to be the same as that of the coil widths (i.e., $a/b = a_f/a_t$).

These functions are plotted with red curves in Figure 2 (page 65). The red dots show 95th percentiles that indicate location errors containing 95% of detections obtained by Equation 5 (below).

$$d_q = \sqrt{2\sigma^2 \ln(1 - q)}$$

Equation 5.

Here, q is the quantile to calculate, which is 0.95 in this case. Figure 3 (above left) shows the modes and 95th percentiles estimated for each metal-detector model and operator, and Table 2 (above left) shows values averaged over all operators for each metal-detector model. Moreover, the percentage of detections within 5cm radius were obtained by setting $d = 5$ cm in Equation 4 (left) and is shown in Figure 4 (above).

Discussion

Prior to the discussion on the results, note that CEIA MIL-D1 is the only detector in this analysis using a double-D coil configuration and requires a different way to pinpoint a target as shown in Figure 5 (previous page). With single-receiver-coil detectors (all the detectors other than CEIA MIL-D1 in this experiment), an operator tries to find signal-start positions from different sides, and the center of the area indicates the target's location. With double-D detectors, an operator tries to define lines where the signal tone changes from two or more sides, and the intersection indicates the target location. Thus, double-D coil detectors can indicate the location directly and more accurately. Only two major manufacturers produce metal detectors with the double-D coil configuration for demining purposes: CEIA and Foerster.

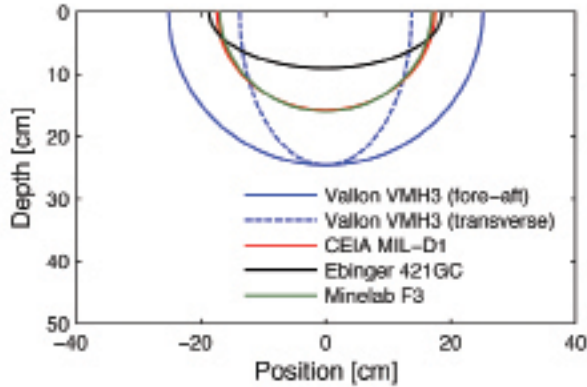


Figure 7. Estimated sensitivity profiles in the fore-aft direction (solid lines) and transverse direction (dashed lines) for a target equivalent to a 10mm 100Cr6 ball. The profiles were obtained by fitting ellipses to the STEM D Lab Test data and interpolation. Since all the detectors except Vallon VMH3 have circular search heads, their sensitivity profiles in transverse direction are assumed to be the same as those in fore-aft direction.

The difference in mode (errors most frequently occurred and blue circles in Figure 3 (previous page) among detector models is not large; they are all in the 2–3 cm range. However, the differences in 95th percentiles (error that includes 95% of detections and red circles in Figure 3 (previous page) and the percentage of detections within a 5cm radius (circles in Figure 4 previous page) are relatively clear. The main cause of the different pinpointing accuracies is the sensitivity-profile size, also known as the footprint, which is a three-dimensional area below the search head where a metal detector gives an alarm for a certain target. As depicted in Figure 5(a) (previous page), the center of the area can be estimated more accurately if the perimeter where the metal detector signal starts is closer to the target location. A detector with a smaller sensitivity profile gives the perimeter closer to the target location.

To observe the pinpointing accuracy in relation to the sensitivity profile, the STEM D Lab Test data² was analyzed. The data was measured for various targets, making it impossible to directly compare between different detector models. Therefore, the data was further processed as follows. Figure 6 (previous page) shows that the data measured various sizes of 100Cr6 balls⁶ fit to ellipses, and that their major and minor axes (a_f , b_f) indicate widths of estimated sensitivity profiles. The axes were interpolated for each detector model to obtain those for a target equivalent to 10mm 100Cr6 balls, so that different models can directly be compared. Figure 7 (above) shows the obtained sensitivity profiles. The profiles (solid lines) are in the fore-aft direction, which is assumed the same in the other direction (i.e., $a_f = a_t$) for CEIA MIL-D1, Ebinger 421GC and Minelab F3 because of their circular-shaped coils (i.e., $a = b$). Vallon VMH3 has oval-shaped coils and the profile in the transverse direction is narrower than that in the fore-aft direction (i.e., $a > b$ and $a_f > a_t$). The detector's operators usually turn the search head and always

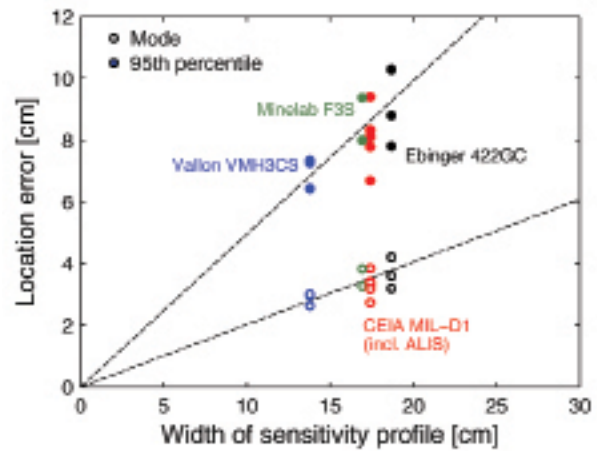


Figure 8. Location error (obtained from the ITEP 2009 test) as a function of the sensitivity-profile width (obtained from the STEM D Lab Test). The width is defined as twice the axis length of the sensitivity profile in the transverse direction. The circles and dots indicate mode and 95th percentile, respectively. The dashed lines are the linear data regressions for the single-coil detectors.]

scan in the transverse direction to define the lines for pinpointing. The profile in the transverse direction (red ellipse in Figure 6, previous page) therefore needs consideration; it was calculated by the ratio of the search head's length and width (i.e., assuming that the length-to-width ratio for the search head is the same as that for the footprint, $a/b = a_f/a_t$). The obtained sensitivity profile of Vallon VMH3 in the transverse direction is shown with the blue dashed line in Figure 7 (left).

The indications of the pinpoint accuracy (modes and 95th percentiles) obtained from the ITEP 2009 test are plotted as a function of the sensitivity profile width, defined as twice the axis lengths of ellipses in the transverse direction (i.e., $2a_t$) in Figure 8 (above). Only four metal detector models are available in both tests that can be compared. Although such a small number of data is available, a relationship between the sensitivity width and pinpointing accuracy can be observed as a linear correlation. A detector having a smaller sensitivity profile can seemingly achieve higher accuracy, and a detector with a larger sensitivity profile seems less accurate. This observation confirms the source of the location error. Single-coil detectors pinpointing a target in the way, shown in Figure 5(a) (previous page), do not indicate the target location directly. The operators estimate it from the perimeter where the detector signal starts. Therefore, the distance from the perimeter to the target location can cause errors. The linear regressions showing the correlation between the sensitivity-profile width and pinpoint accuracy for single-coil detectors are plotted in Figure 8 (the regressions do not include the data of CEIA MIL-D1).

Double-D coil detectors (e.g., CEIA MIL-D1) may not have a direct relationship between the sensitivity-profile width and accuracy. This detector type is considered to be capable of locating a target very accurately, as the STEM D Lab Test demonstrated.² However, more training or more experience may be required to achieve such a high pinpointing accuracy as the comparison between CEIA MIL-D1 and ALIS indicates (operators who had a two-day training prior to the test used CEIA MIL-D1, while ALIS operators have occasionally used the detector for a longer period). The operators of CEIA MIL-D1 in the ITEP 2009 test might not have enough working experience on the detector to demonstrate the high accuracy in a field condition and to achieve a similar accuracy level as with the other detectors.

The detectors used in the STEM D Lab Test to measure the sensitivity profiles are not exactly the same models used in the ITEP 2009 test; however, these sensitivity profiles were assumed

to be similar between models, because the size of the search head never changed. Therefore, little modification between models can be assumed, and results between older and newer models will be similar.

Conclusion

A method to analyze blind-test data of metal detectors for evaluating the pinpoint (location) accuracy is discussed and demonstrated with the data from the ITEP 2009 test. By this method, the pinpointing accuracy of metal detectors under field conditions is obtained as a mode and 95th percentile, indicating a pinpoint error that frequently occurs and includes 95% of detections. Additionally, the percentage of detections with-

“...the information may be used to establish an operating procedure for detection and safe excavation of landmines.”

in a certain area is also calculable. Using the method for the data acquired in a blind test, a metal detector's location error can be assessed, and the results can be used for the selection of a detector model. Moreover, the information may be used to establish an operating procedure for detection and safe excavation of landmines. For example, the perimeter of the path where deminers should begin excavating toward a target can more accurately be defined if the success and error rate of metal detections based on the model they use is known to the operators.

The location-accuracy stats obtained from the ITEP 2009 test was also discussed in relation to the way to pinpoint correctly and the differences in the sensitivity profiles of detectors. The data show a linear correlation between the pinpoint accuracy and the sensitivity profile for single-coil detectors. The result shows that a detector with a smaller search head produces more accurate results than larger search heads, making the smaller search heads generally better for locating targets. However, consider some other points when selecting a metal-detector model: A smaller search head is less sensitive to clutter, which also means it takes more time to thoroughly scan an area.⁷ Oval-shaped coils and double-D configuration may be good approaches for this trade-off. On the other hand, even with a larger coil and wider sensitivity profile, accurately pinpointing a target is possible. As shown in Figure 7 (page 67), a sensitivity profile is elliptical in the vertical section, and the width becomes narrower farther from the coil. By lifting up the search head from the ground surface, a smaller part of the sensitivity area can be used for pinpointing. Experienced operators often use this technique to increase accuracy.

Sensitivity profile is influenced by many properties as theoretical works^{7,8} and experiments⁹ have exhibited, such as the coil and electronic design of the devices, metal content and shape of the target, magnetic and electrical properties of the soil, etc. When clearance operations are planned at a site, the metal-detector model is the only choice users can make, and this determines the sensitivity profile and associated performance. Therefore, the choice is very important.

In the detection-performance analysis of blind tests, the concept of **halo radius** that sets a circular area around a target to define hit or miss was commonly used. In the CEN Workshop Agreement, the halo radius is “half of the maximum horizontal extent of the metal

components in the target plus 100mm.”¹⁰ It is a circular area with a 5cm radius for a point-like metal target. According to the results shown in Figure 4 (page 66), 60–80% of the detections are correctly counted as a hit, but the remaining 20–40% of detections are not, by the halo definition, counted as a hit, because despite detecting the targets, these detections are outside of the halo. Obtained in this way, results may not show detection performance, but they include pinpointing performance in part. Thus, the definition in the CEN Workshop Agreement sounds a little too strict to evaluate only the detection performance.

In the ITEP 2009 test, only a few operators per detector model were available. The number is unfortunately too small to discuss the difference between different operators. Since the accuracy of metal-detector pinpointing probably depends on the operator's skill and experience, this point could be investigated further, if and when more operators are available. ◀

See endnotes page 83

The author is grateful to Dieter Gülle with Mine Action Consulting, Berlin, Germany, for his helpful suggestions and Dr. Adam Lewis with the Joint Research Centre, European Commission, Ispra, Italy, for providing the STEM Lab Test data. He also wishes to acknowledge colleagues at the Technical Center for Protective and Special Technologies and the Federal Office of Defense Technology and Procurement (BWB), Oberjettenberg, Germany, for their support in collecting data. A special thanks to the manufacturers for providing their products (i.e., metal detectors) and trainers, and for actively seeking testing. The author is also grateful to BWB for supporting the work.



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Lateral-approach Methodology and HSTAMIDS

MAG Cambodia has used the Handheld Standoff Mine Detection System (HSTAMIDS) with lateral-approach methodology for three years within an operational field evaluation funded by the U.S. Department of Defense's Night Vision and Electronic Sensors Directorate. MAG's current research tested the productivity of two ways of using LAM combined with HSTAMIDS against the productivity of the traditional one-man one-lane drill methodology; this article presents the findings.

by Clifford Allen and Shathel Fahs [MAG Cambodia]



An operator using a long-reach tool.
All photos courtesy of the authors.

Lateral-approach methodology is the method by which a minefield is cleared along its linear boundaries rather than by breaching clearance lanes every 25m at 90 degrees to the linear boundary into a minefield. This is done by selecting the longest and most conveniently accessed boundary and advancing into the minefield laterally or in extended-line approach. LAM is broken down into phases that can differ in number depending upon the terrain encountered.

LAM is not a new concept; The HALO Trust developed it about half a decade ago when the organization first began deploying the Handheld Standoff Mine Detection System (HSTAMIDS), a metal detector with ground-penetrating radar capabilities, in the field. MAG (Mines Advisory Group) adopted the methodology in November 2007 and has since altered it many times to improve productivity and ease the burden on deminers.

Procedure

Prior to Phase 1, the lane is marked using a red rope with white markers painted or taped onto the rope every meter. The operational field evaluation then begins the following phases for clearance:

1. Quick search
2. Vegetation-cutting/rock removal
3. Raking and blowing
4. Marking
5. Detection
6. Manual excavation
7. Rapid-excavation drill

Quick search. In Cambodia, the tripwire threat is considered non-existent; consequently, the first phase entails conducting what is known

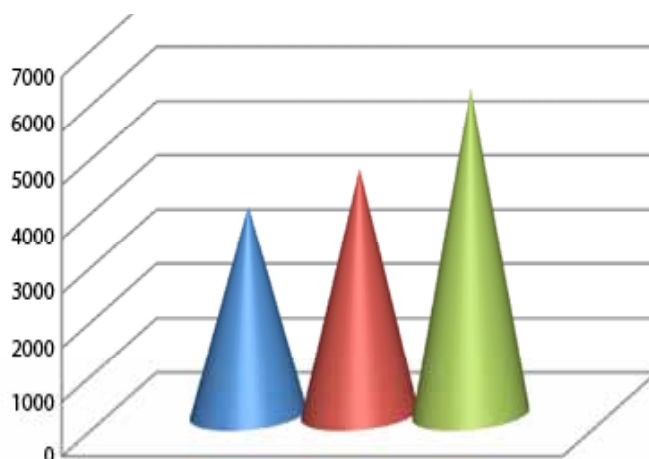


Figure 1. Progress in square meters during the transitional period from OMOL to LAM.

Blue: July 2010/OMOL
 Red: August 2010/OMOL-LAM
 Green: September 2010/LAM
 All graphics courtesy of the authors.

as quick search using a conventional metal detector that involves thrusting the detector up to 1.2m in and out of the uncut vegetation, moving laterally along the front edge of the area to be cleared, and looking and listening for large signals that may not be at first visible. Any such signals encountered are marked as an obstacle, signifying that these areas are not to be mechanically cut. If it is safe to do so, recognizable surface clutter is removed.

Vegetation-cutting/rock removal. The second phase is cutting the vegetation down to ground level using mechanical means. A long-reach tool with a strimming (mechanical vegetation-cutting) attachment is used in three patterns for various vegetation types. Strimming and rock removal of previously marked quick-search areas are avoided; these areas must be cut manually with secateurs or similar hand-cutting tools. This phase sometimes requires extra work because deminers must remove rocks from the lane first. Rocks are often prevalent on hillsides where mines were deployed to protect key installations.

Raking and blowing. The cutting phase is followed by the removal phase, which can involve hand clearance of large vegetation. This phase is backed up by raking and brushing, and culminates in the use of another long-reach tool with a blower attachment, leaving the lane to be cleared free of vegetation, loose soil and even some surface metal. Magnets can also be deployed at this stage if the area contains large amounts of surface-metal clutter.

Marking. The red rope may have moved and be out of alignment due to the previous phases of strimming, raking and blowing, so it may have to be adjusted prior to marking. After these adjustments, a blue rope is placed 0.6m into the uncleared area running parallel to the red rope. This creates 1m x 0.6m cells along the length of the lane. The area cleared within each lateral lane is 0.5m, with the other 0.1m designated as overlap. The overlap area is covered twice as the lane progresses forward. Spacers are used every 8m to ensure the ropes are kept straight and parallel.

Lanes are normally defined as being 25m in length but can be any length. These 25m lanes form a grid that is logged by numbers and letters, allowing accurate data collection so that data can be used for quality-control/quality-assurance investigations as well as assisting in mapping, etc. The practice of working at some considerable distance greater than 25m is to be encouraged where the supervisor can observe all activity from a central focal point.

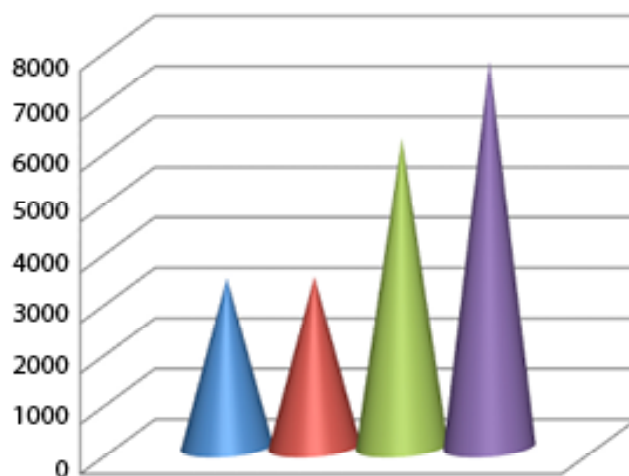


Figure 2. Progress in square meters before, during and after the introduction of HSTAMIDS into LAM.

Blue: July 2010/Without HSTAMIDS
 Red: August 2010/With HSTAMIDS-No RED
 Green: September 2010/HSTAMIDS with RED
 Purple: November 2010/Progression of HSTAMIDS

Detection. The next phase is detection or clearance, and it can be executed using either conventional metal detectors or HSTAMIDS. If the former is adopted, the deminer starts a systematic search, sweeping sideways in straight lines, placing red chips on all signals encountered. If HSTAMIDS is used as the primary search tool, the detector operator can immediately differentiate between metal clutter and possible mines, and the operator places blue and red chips (markers) accordingly.

If the area being detected has many signals per cell, then a magnet can be utilized to reduce surface clutter. A senior deminer or a superior, such as a supervisor in Cambodia or a deputy team leader in Angola, should supervise this activity to negate any missed signals. The procedure is to lift a chip and sweep the magnet over the area where the chip was placed, attracting metal fragments to the magnet. A detector is then passed over the area again, and if the signal has disappeared, the chip is removed. However, if the signal remains, the chip is again placed on the spot for further action. When the cell sweep is completed, the operator moves the sensor/search head forward and continues with the next sweep. The operator progresses to the blue-colored rope, thus creating overlap. Overlap should also be maintained at the front and ends of all cells.

If a conventional metal detector is used for detection and marking of the entire lane with red chips, the HSTAMIDS detector then verifies all red chips placed by conducting isolation and moving in a zigzag motion over each chip. Since HSTAMIDS costs upwards of US\$16,000–20,000 and conventional metal detectors cost roughly \$3,000, the use of a conventional metal detector is often used in place of HSTAMIDS. On the other hand, HSTAMIDS' GPR sensors allow the operator to change up to 95% of the red chips to blue, which identifies the remaining 5% as being the only red chips necessary to manually excavate. If the HSTAMIDS is deployed as the primary clearance tool, then the blue and red chips are placed concurrently, depending on the signals HSTAMIDS gives.

Manual excavation. The next phase involves manual clearance with the help of a conventional metal detector. The deminer observes the lane for chips and moves to where the first red chip is placed. If this is, for example, in cell 4, then the excavation deminer will manually excavate that signal using conventional standard-operating-procedure excavation drills, which is done by centralizing the chip using the metal detector. No sweeping toward the signal is required. If the chip is in the correct position, as indicated by the detector, the operator will proceed to excavate the signal location, moving along the lane until all locations

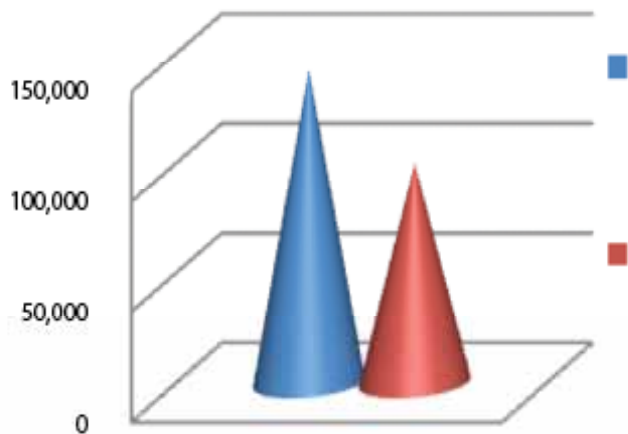


Figure 3. Square meters achieved over a six-month period.

Blue: 9x HSTAMIDS
Red: 18x Metal detectors

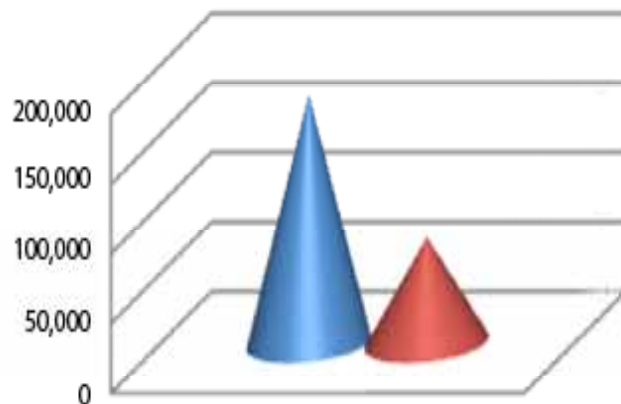


Figure 4. Metal contamination encountered over a six-month period.

Blue: 9x HSTAMIDS
Red: 18x Metal detectors

are excavated. Mines are not completely excavated; they are only partially excavated to allow a donor charge to be placed alongside unless they are to be neutralized or disarmed. QC/QA is then conducted on the excavations, and any mines are destroyed *in situ*.

Rapid-excavation drill. The final phase is to proceed to rapid excavation of all blue chips using mechanical means, which is carried out by an operator using a long-reach tool with a digging attachment. This procedure is known as a rapid-excavation drill. The long-reach tool operator will excavate each blue chip by digging a trench to the rear or side of the blue chip as per manual drill, and will force their way forward with the long-reach tool until the operator is just behind or alongside the chip. At this point, the operator must stop the digging bit from revolving and brush the chip into the excavation behind or alongside the chip's position before continuing excavating 5cm beyond the place where the chip was originally lying.

Brushing the chip aside to continue excavation 5cm beyond will ensure that all items will either be uncovered or flung to the side, and will enable the long-reach tool operator to determine the source of the signal. Once all the rapid excavations are completed in a given lane, the lane is deemed clear, and the next lane can be prepared. The rapid-excavation drill procedure achieves final quality assurance.

Modifications to LAM

Since the inception of LAM, a number of innovative ideas were adopted, and most of these have come from the deminers on the ground. For instance, since MAG first utilized LAM and the introduction of rapid-excavation drill in November 2008, marking has seen substantial changes. This methodology was simplified and re-engineered to optimize productivity.

Two improvements in the process were made. First, the red rope with white markers has eliminated the need for conventional minefield pickets at every meter, thereby removing these obstacles for the deminers. Second, the way in which these ropes are deployed, by means of polyvinyl chloride pipe reels and stakes, is also an improvement. MAG is continually rethinking marking to increase efficiency.

Even without HSTAMIDS, evidence suggests LAM is easier to control, has improved safety benefits, and is more cost efficient on marking materials than the one-man, one-lane drill methodology. LAM could better benefit road/verge clearance than the current method of clearing

with the one-man, one-lane drill methodology. These productivity advantages can be seen in Figures 1 and 2 (previous page).

On the other hand, using HSTAMIDS in LAM is additionally advantageous in a number of ways:

- As shown in Figures 3 and 4 (above), substantial increases in productivity occur.
- The number of time-consuming and labor-intensive manual excavations are minimized.
- Using a blower is seen to have morale-boosting effects on deminers as it clears everything from the lane in a less labor-intensive way. Removing some surface metal and stones means the detector operators have an easier time sweeping the detector close to the ground for better detection.
- Using magnets before and after chipping, depending upon contamination levels, is a time-saver. If a lot of surface clutter is encountered, then the magnet can be swept over the cell before the detector is deployed. Correspondingly, after chipping, the magnet can be deployed on selected targets, particularly around red chips that can then be discounted if the magnet detects and lifts the offending signal from the surface.

In a conventional minefield, the standard operating procedure for MAG Cambodia states that the safety distance between any working deminers should be not less than 25m. However, this distance is largely because all deminers work independently, and 25m is the default distance that most demining organizations worldwide adopt in anti-personnel minefields. Due to the nature of the methodology covered above, not all activities are deemed equally hazardous or potentially so. Therefore, the authors devised a system pertaining to the nature of the activity shown in Table 1 (next page) giving various distances that should not be exceeded.

Use of and Adaptations to Long-Reach Tools

MAG used Honda long-reach tools for strimming before it began using LAM. However, since MAG began using LAM with HSTAMIDS, a range of tools designed for gardening produced by Stihl, a German manufacturer, were procured. These tools were modified in many ways to adapt them for the demining industry. For example, the shafts MAG uses are half shafts held together in the center by a coupling, which has also been modified. This facilitates quick tool change—a shaft change

| Activity | Hazardous | Non-hazardous | Safe Distance |
|-------------------|-----------|---------------|---------------|
| Marking | | x | 5m |
| Quick search | | x | 10m |
| Sawing | x | | 25m |
| Strimming | x | | 25m |
| Raking | x | | 25m |
| Blowing | | x | 10m |
| Lane preparation | | x | 10m |
| HSTAMIDS | | x | 10m |
| Data Collection | | x | 5m |
| Manual excavation | x | | 25m |
| Rapid excavation | x | | 25m |
| QA | | x | 2m |

Table 1. LAM safety distances.

takes one minute, whereas a complete tool change can take up to 15 minutes and can cause more wear and tear on the tool head connection. MAG also radically modified the shafts to make them more robust. By changing the outer casing from aluminum to steel and by exchanging various components manufactured in plastic to steel alternatives, the working life of these components has been greatly lengthened.

Gear heads supplied by Stihl are flimsy for the type of application MAG requires and have been replaced by a much cheaper and more robust Honda version that has stronger bevel gears and an outer casing.

Along with the introduction of a variety of attachments, the strimming procedure was refined. By sweeping the strimmer from right to left, for example, in a half circular motion, the cut vegetation is dragged toward the red rope and thus reduces vegetation left in the uncleared area, alleviating part of the raking and blowing. Using different cutting blades and circular saw attachments has optimized the activity further.

Introducing a 90-degree plasticized polyvinyl chloride bend to the blower's end also helped develop the blowing technique. This change allows the debris to be more easily blown into the cleared area, minimizing the operator's effort. The blowing is done in roughly the same manner as strimming, bearing in mind MAG is not looking for a metal-free minefield. Drive shafts were modified, and the locating pin was replaced by placing a bearing on the shaft to stop oscillation.

Sometimes overhanging trees and bamboo must be removed before clearance. Teams are supplied with chainsaw attachments to deal with the heavier branches and bamboo shoots. These saw attachments on the end of a half shaft are easier to transport and operate than a completely independent chainsaw.

Various digging devices were trialed and mostly discarded, although the cutting blades designed by engineers at NVESD have had some success in soil that is not densely compacted and is largely free of rocks and roots.

The rapid-excavation drill uses the pineapple drill head, which is the mainstay of mechanical-excavation activity.

Two Methods of Clearance Utilizing HSTAMIDS

The agreement between MAG and NVESD is that HSTAMIDS should be the primary clearance tool; therefore, the lateral-approach methodology was largely developed with this in mind. More recently, the purchase of additional HSTAMIDS units, funded by the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), is allowing MAG to experiment with other approaches outside of the NVESD operational field evaluation.

The OFE methodology has evolved as three-by-three-person sub-teams, each with an HSTAMIDS detector and all the ancillary equipment needed to conduct operations. Each sub-team is allocated an area of the minefield and concentrates its efforts in this area only. Each member of the sub-team is multi-skilled in as many of the activities as possible needed to conduct operations, thus allowing for flexibility and continuity. These three individuals can operate the various phases independently and without strict supervision. Each team member knows what the next step is and equips themselves with the necessary equipment from a focal point (rest area) close to their working lane, which has been found to work very well provided that the sub-team is continually allocated between five and seven lanes minimum to allow for observation of safety distances while conducting constant activity.

Teams outside the OFE are equipped with one HSTAMIDS detector and two operators and they support a number of metal detector operators. The team is roughly divided into two parts. On average, five or six conventional metal-detector operators are deployed, conducting quick search and marking all signals in lanes with red chips. This practice ensures that the HSTAMIDS has sufficient work to sustain it for an entire day. Later, these operators also manually excavate red chips that remain after HSTAMIDS has verified them.



The basic design of the pineapple and the alignment of drill heads maximizes the potential for digging.



Each mine triangle represents a partially manually excavated mine.

The other team members (up to six in a standard MAG mine-action team configuration) perform the other activities, which revolve around the long-reach tools. These are strimming, cutting, sawing, blowing and rapid-excavation drill. All of the operators are also involved in marking when the HSTAMIDS is being used as the verification detector.

This methodology needs further study to ascertain whether this procedure should be altered to remain flexible in order to account for varying contamination levels. Metal contamination is the main factor governing the number of metal detectors deployed at any given time because this affects whether more than one HSTAMIDS detector is necessary.

Productivity

MAG continually strives to increase efficiency and effectiveness, and the introduction of HSTAMIDS has greatly enhanced its ability to do so, as illustrated in Figures 3 and 4 (page 67). LAM's success significantly improved with the introduction of HSTAMIDS to the toolbox.

Conclusion

The methods MAG Cambodia uses when deploying HSTAMIDS with the lateral-approach methodology exhibit certain advantages when compared with the traditional one-man, one-lane approach, particularly with regard to productivity. The analysis of HSTAMIDS and LAM is still an ongoing process within the program with further technological advances and improvements in productivity expected.

The various outlined approaches are open for improvement and adjustment, with expectations that as HSTAMIDS is introduced into other programs, the improvements in these methodologies will ensure that HSTAMIDS and LAM continue to give significant benefits over standard metal detectors and more conventional clearance methodology. ◊



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LOCOSTRA: Blast-resistant Wheels Test

Technical Survey, often an efficient method of achieving land release, can also be prohibitively expensive for certain communities due to the utilization of the same hulking, heavily-armored machines used in clearance operations. If Technical Survey could be achieved through the use of less expensive agricultural equipment that is already present in communities near suspected areas, land release could be achieved at a much lower price. The following study explores this possibility by examining the explosion resilience of four different designs of blast-resistant tractor wheels, each made of commercial off-the-shelf components and designed for easy reproduction in mine-affected communities.

by Emanuela Elisa Cepolina [Snail Aid – Technology for Development], Matteo Zoppi [PMARlab, University of Genoa] and Vittorio Belotti [PMARlab, University of Genoa]





| Wheel n° | Wheel Name (used only for reference in the text) | Description | Characteristics | |
|---|---|-------------|-----------------------------------|---|
|  | 1 | All steel | Vented steel wheel | External diameter: 900mm Width: 235mm Weight: 85kg Steel thickness: 4mm |
|  | 2 | Florida | Embedding a small inflatable tire | External diameter: 900mm Width: 205mm Weight: 86kg Steel thickness: 4mm Inner wheel: inflatable tire wheel (trailer) with tube, external diameter of 500mm |
|  | 3 | EPR | Embedding a large inflatable tire | External diameter: 890mm Width: 250mm Weight: 161kg Steel thickness: 10mm Inner wheel: inflatable tire wheel (4WD vehicle) tubeless, external diameter of 750mm |
|  | 4 | Genoa | Embedding a solid rubber tire | External diameter: 865mm Width: 205mm Weight: 118kg Steel thickness: 4mm Inner wheel: solid rubber wheel (fork-lift truck), external diameter of 595mm |

Figure 1. Wheels tested.
All graphics courtesy of PMARlab.

During May and June 2010, a series of comparative tests were conducted with four different designs of blast-resistant wheels built in the context of the LOCOSTRA (LOW COST TRActor) project. Tests took place in an open-air quarry named Valcena near Parma, Italy. Three different types of charges containing 120g of Goma2Eco plastic explosive, 120g of TNT powder and 240g of TNT powder, respectively, were used in the tests.

The wheel prototypes were designed to resist physical damage and protect the vehicle on which they are mounted by consistently absorbing the resulting shockwaves caused by anti-personnel mine explosions. Because the wheels were developed with off-the-shelf material, they were simple and affordable. Moreover, they were designed for easy repair in local, nonspecialized workshops and, therefore, are appropriate for developing countries. The average cost of each wheel produced was 850€

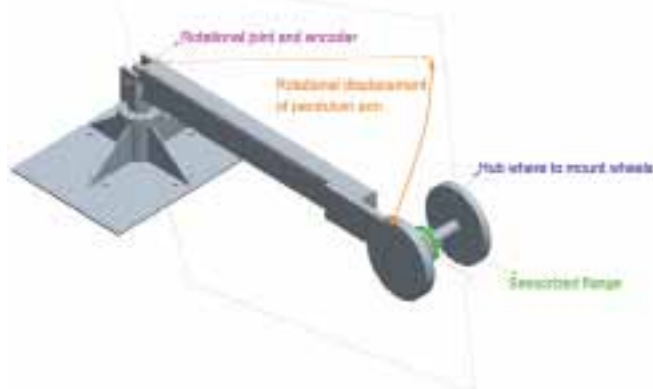


Figure 2. Pendulum digital mock-up and prototype set-up before the test.

(US\$1,187).¹ The results from these comparative tests may be of great interest to the mine-action community.

The Problem

The global community is witnessing an increase in poor countries' vulnerability to weather and economic volatility—in other words, a decrease in their resilience. Resilience shares a strong link with investments in agricultural technologies, and the cause of decreasing resilience traces back to poor agricultural investments. While Africa's development aid has increased by 250% since the early 1980s, the allocation to agriculture has halved.² As the land's importance and value increases daily, releasing mine-suspected areas to local communities more quickly is increasingly necessary.

Luckily, many different countries are using Technical Survey to release land faster than in the past. While being quicker, though, the process is not inexpensive. Often, in fact, the machines used to process the ground in Technical Survey are the same employed for full clearance: expensive, heavily armored, highly powerful machines. As Technical Survey aims at verifying mine absence, machines used in Technical Survey are mainly employed on uncontaminated land. If an explosion occurs, these machines are withdrawn from the field, and the area is treated with other more accurate methods.³ If ground-processing agricultural technologies are used as verification assets instead, a win-win solution can be achieved by enhancing long-term development and community resilience.

Within this context and upon these considerations, the LOCOSTRA project⁴ started in November 2009. The project, ended in May 2011, led to the development of a low-cost machine based on a small four-wheel drive tractor to perform Technical Survey that is now sold at 50,000€ (\$69,795). The tractor has a 79hp Deutz[®] diesel engine and a hydrostatic transmission. It has a double-steering system, is reversible, has a power takeoff and a standard three-point linkage system able to lift up to 1,800kg. Every kind of agricultural tool with standard three-point linkage attachment can be mounted on LOCOSTRA; until now it has been equipped with a mulcher, provided by FAE-Advanced Shredding Technologies and a ground-processing tool produced by NARDI – Agri-

cultural Equipment. The machine has been equipped with a large loop detector donated by Ebinger and another agricultural-derived sweeping tool is under study at the University of Melbourne.

The tractor on which the LOCOSTRA is based is slightly modified to host an industrial dual remote control. This means that no manual on-board controls are modified or removed, and the operator can drive the tractor or operate it remotely. The tractor is also equipped with light armoring composed of 3 mm-thick, steel deflection plates and new blast-resistant wheels.

This article presents results from a comparative test of four different designs of blast-resistant wheels made with commercial off-the-shelf components and designed for easy production in local workshops in mine-affected countries.

Blast-resistant Wheels

Each of the four wheels prototyped and tested was designed to withstand blasts and to limit shockwave transfer to the relevant parts of the vehicle to which the wheels are mounted. In particular, blast-resistant wheels have been designed to:

- Withstand 240g of TNT and resist at least five explosions before maintenance is needed
- Keep the tractor safe by reducing the shockwave transmitted to the hub to harmless levels
- Be inexpensive
- Be easy to repair locally
- Have good traction
- Be lightweight

The four wheels are design variations of a concept intended to maximize shockwave venting and/or shockwave absorption via a flexible inner wheel, originally conceived by Andy Vian Smith, an active participant in the design. Figure 1 on page 71 shows the four wheels with their numbers and characteristics. Within the text of this article, wheels are identified either by the dummy names or the numbers indicated in Figure 1.

Test Method

The test aim was to compare the four designs and assess which wheel was better at:

- Resisting physical damage
- Significantly reducing the energy transferred to the tractor

To measure the energy transferred, two sensors were employed: a rotary encoder and a tri-axial accelerometer. The incremental encoder, which was produced by Stegmann Inc., has a sensitivity of less than one-tenth of a degree. It was mounted on a ballistic pendulum (Figure 2), designed to hold the wheels while they were subject to blast testing. The pendulum was designed to have one degree of freedom with the pendulum arm free to rotate around a joint sensorized with the encoder, which is able to measure its angular displacement. The weight the pendulum





| | pendulum/ tractor |  TNT | n° wheels tested |
|---------|---|---|---------------------|
| phase 1 |  | 120g of Goma2 Eco | 4 |
| phase 2 |  | 120g & 240g of TNT | 4 |
| phase 3 |  | 240g of TNT | 2 |

Figure 3. Test phases.

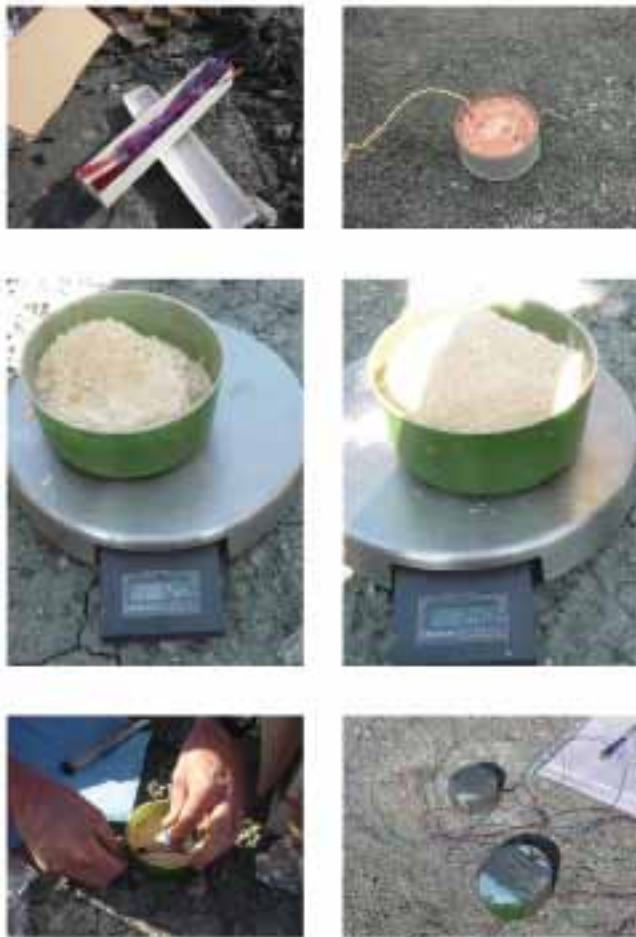


Figure 4. Charges.

exerted on the wheel was adjusted by adding counterweights at the back of the pendulum. Each wheel was held firmly on the pendulum hub using bolts of the same diameter as those used on the LOCOSTRA. Between the wheel and the pendulum hub, a sensorized flange allowed for measurement of the hub's acceleration.

The encoder allowed the measurement of the energy transferred by each wheel by recording the pendulum arm's rotational displacement and, in particular, the maximum height reached by the arm during each explosion. The height reached is directly proportional to the energy transferred, because when the pendulum stops for an instant at the highest position, all its energy is in the form of potential energy.

The tri-axial accelerometer placed inside the flange was used to record hub acceleration. It was used on the pendulum as well as on the real tractor hub during the test's final phase, when the wheels that performed better on the pendulum were mounted on the tractor and tested in realistic conditions.

Acceleration is directly proportional to the force exerted on the hub by the blast wave. As the structure reacted, vibrating from the blast wave impulse, the recorded acceleration was oscillatory. In order to compare the wheels, data was processed to obtain the root mean square values of acceleration (a sort of average value of the acceleration over time), a value that measures the power of the blast wave passing through the wheel.

The accelerometer has sensitivity of $0.05\text{mV}/(\text{m}/\text{s}^2)$ and measurement range of $98,000\text{m}/\text{s}^2$. The frequency range is $3\text{--}10,000\text{Hz}$. It is tri-axial, and therefore allowed measurement of the acceleration components on the wheel plane and on the axis perpendicular to the plane.

A high-speed camera recorded a maximum of 20,000 fps in good lighting conditions and recorded the whole event, cross-checking the

data obtained with other sensors. The other three cameras were traditional and recorded the explosions from different positions.

The test was divided in three phases (Figure 3 on page 72). During Phase 1, each wheel was mounted on the pendulum weighing 250kg (as wheels had slightly different weights, different counterweights were used to achieve the desired weight) and tested against 120g of Goma2Eco plastic explosive. During this first phase, the weight was kept to a low value to ensure an appreciable rotational displacement. This allowed researchers to compare wheel performance based on the amount of potential energy transferred. The encoder also recorded the pendulum arm's rotational displacements in subsequent tests, when the weight on the pendulum was increased to a realistic value (approximately one-fourth of the tractor weight).

During Phase 2, each wheel was mounted on the pendulum weighing 500kg (again, counterweights were employed) and tested first against 120g of TNT and later against 240g of TNT.

During Phase 3, only the two wheels that performed best in previous phases were mounted on the tractor and tested, one against 240g of TNT and the other against 120g of Goma2Eco. Only one wheel was supposed to be tested on the tractor during Phase 3; in the field, however, two wheels performed well, and it was decided to investigate both further. Before mounting the wheels on the tractor, the same sensorized flange hosting the tri-axial accelerometer used on the pendulum was mounted on the tractor hub.

Charges (Figure 4 to the left) were prepared in the field by filling plastic containers ranging 35mm–90mm in diameter with the explosive required by the test phase. No covers were used, but, in the case of TNT, when containers were filled with TNT powder, Duct tape was used to secure some fabric firmly on top of the pressed powder. In order to increase reproducibility, a hole was dug under the pendulum arm, and a thermalite block (Figure 5) filled in the hole above. Some gravel was placed on top and around the charge, closing the gap between the wheel and the charge. After each test, the thermalite block was replaced with a new one. Two small wood pieces held the wheel on the thermalite block at the required distance of 20mm from the top of the explosive.

Charges were actuated by an electric detonator initiated remotely. After each explosion, each wheel was rotated in order to face the charge with a different part not yet deformed by previous explosions.

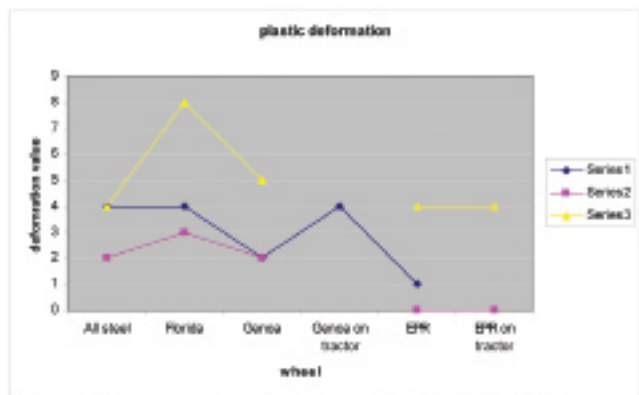
Results

Wheels were evaluated on the basis of their capability to retain mechanical integrity and to reduce the energy transferred to the tractor. Several findings resulted.

Mechanical integrity. Wheels were evaluated primarily on the ba-



Figure 5. Placement of the charge underneath the wheel and thermalite block.



Series1 is 120g of Goma2Eco, Series2 is 120g of TNT, Series3 is 240g of TNT

| Wheel | Points (total) | Classification |
|-----------|----------------|-----------------------|
| All Steel | 4+2+4=10 | 1 |
| Genoa | 4+2+5=11 | 2 |
| Florida | 4+3+8=15 | 3 |
| EPR | 1+0+4=5 | 4, due to ovalization |

Figure 6. Results—mechanical integrity.

sis of their ability to retain mechanical integrity after three consecutive blasts, with 120g of Goma2Eco, 120g of TNT and 240g of TNT respectively. Mechanical integrity was assessed in terms of:

- Loss of any wheel parts (including tread)
- Splitting or separation of material between welds
- Cracking or separation of welds
- Permanent deformation of steel parts
- Damage to rubber parts

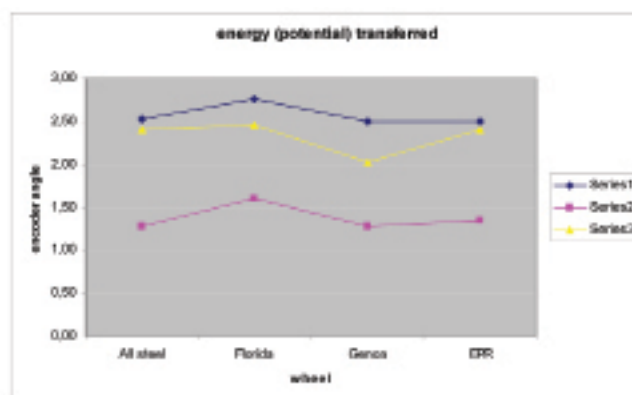
As similar damage could be identified for each wheel, points were assigned to each particular impact and wheels scored on the basis of the sum of marks obtained. Wheels scoring fewer points were considered the best (Figure 6 above). For a clearer picture, Figure 6 sums up points scored by each wheel in all the three tests. In the case of a wheel also tested on the tractor, the worst point obtained between the pendulum and the tractor was considered.

Two wheels passed Phase 2 and therefore were also tested on the tractor during Phase 3. These are wheel n. 3 (EPR) and wheel n. 4 (Genoa). Wheel n. 3 (EPR) was tested twice more—first against 120g of TNT and then against 240g of TNT. Wheel n. 4 (Genoa) was tested only once more against the remaining charge, containing 120g of Goma2Eco plastic explosive.

From the point of view of deformation, wheel n. 3 (EPR) would be the best if it would not ovalize. The ovalization is particularly bad because it cannot be fixed in a workshop. Therefore, the best wheel turns out to be wheel n. 1 (All Steel), as it is less deformed. Next comes wheel n. 4 (Genoa) and then wheel n. 2 (Florida), which is the only wheel presenting separation of material. It has to be considered that wheel n. 3 (EPR) is 10mm thick while all the others are 4mm thick.

All wheels survived at least three explosions without compromising their ability to turn. One (wheel n. 3) survived two more explosions, becoming very ovalized, and one (wheel n. 4) survived one more explosion but retained its ability to turn. Therefore, from the point of view of retaining mechanical integrity, all designs are promising and are worth investigating further.

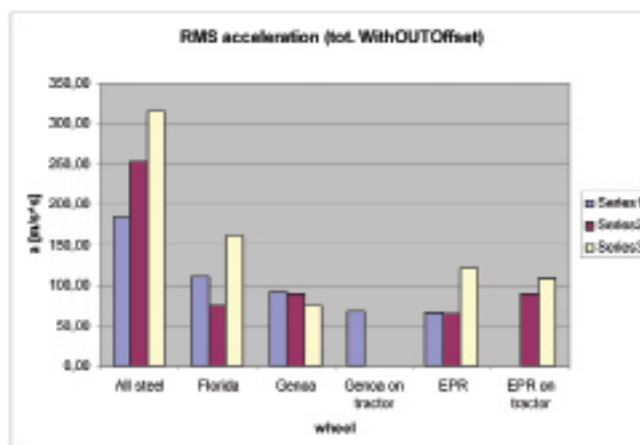
Energy transferred. The second criterion used to evaluate wheel performance was the energy transferred. Energy was measured by two different means: by the encoder placed in the revolute joint between the pendulum arm and the pendulum basis, and by the accelerometer placed



Series1 is 120g of Goma2Eco, Series2 is 120g of TNT, Series3 is 240g of TNT

| Wheel | Encoder value | Classification |
|-----------|---------------------|----------------|
| All Steel | 2.52+1.27+2.40=6.19 | 2 |
| Genoa | 2.50+1.27+2.02=5.79 | 1 |
| Florida | 2.75+1.60+2.46=6.81 | 4 |
| EPR | 2.50+1.34+2.40=6.24 | 3 |

Figure 7. Results—potential energy transferred.



Series1 is 120g of Goma2Eco, Series2 is 120g of TNT, Series3 is 240g of TNT

| Wheel | Acc. RMS total value | Classification |
|-----------|-----------------------------|----------------|
| All Steel | 184.03+254.09+316.07=755.00 | 4 |
| Genoa | 92.77+60.22+74.98=257.97 | 1 |
| Florida | 110.45+75.15+181.76=347.96 | 3 |
| EPR | 66.32+66.05+121.65=277.83 | 2 |

Figure 8. Results—total RMS value of acceleration.

within a flange mounted between the wheel and the hub on the pendulum as well as on the tractor.

The encoder measured the potential energy transferred from each wheel to the pendulum by measuring the pendulum arm's maximum rotational displacement. Figure 7 on page 74 reports the maximum rotational displacement per wheel per explosion. To have a clearer and more global picture, Figure 7 sums up the maximum encoder values scored by each wheel in all the three tests. From this analysis, it can be said that wheel n. 4 (Genoa) transmits less potential energy than the other wheels.

Acceleration of a body is always proportional to the force applied to it. Therefore, by looking at the acceleration of the flange between the

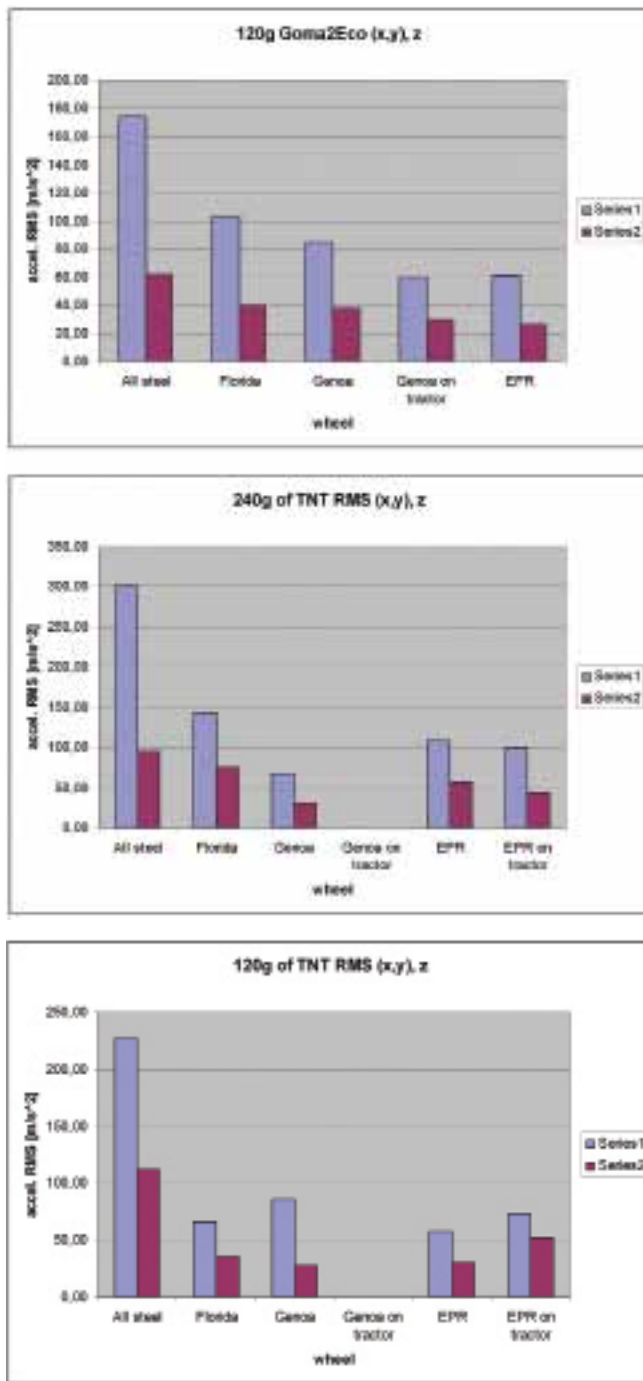


Figure 9. Components of RMS values of acceleration along in x,y plane and z axis.

wheel and the pendulum or the tractor hub, wheels could be compared on the basis of their ability to reduce force transmitted to the tractor.

By processing data recorded by the accelerometer filtered at 500Hz (because frequencies higher than this value are not considered to cause mechanical vibrations), the root mean square values of acceleration (a sort of average value of the acceleration over time) for each wheel and for each explosive type and quantity was obtained (Figure 8 on page 74). To have a clearer picture, the RMS values of acceleration for the same wheel in each of the three explosions were summed up. In the case of a wheel also tested on the tractor, the worst point obtained between the pendulum and the tractor was considered.

By examining the wheels' behavior in each of the three explosions, it can be said that generally, wheel n. 4 (Genoa) transmits less accelera-

tion than the other wheels, although the total RMS value is very similar to that of wheel n. 3. It can also be noticed that wheels embedded with an inflatable tire perform worst against higher quantities of explosive.

Additional results. By observing the encoder values, wheel n. 1 (All Steel) performs quite well at transmitting little potential energy to the pendulum, being the second best wheel after wheel n. 4 (Genoa). Because the design of wheel n. 1 (All Steel) maximizes venting to the detriment of shock dumping, a first general result learned is that ventilation helps reduce potential energy transfer.

When examining the total RMS acceleration values, wheel n. 4 (Genoa) performs better against higher quantities of explosive. As wheel n. 4 (Genoa) embeds a solid rubber tire, it dissipates energy by hysteresis cycles of the rubber, and a higher quantity of explosive actuates more rubber.

Therefore, a second general result is that, in the case of a blast-resistant wheel embedding rubber tire, the more and the softer the rubber, the better.

Figure 9 to the left, showing RMS values divided in two components: acceleration in the vertical plane (x, y) and acceleration in the horizontal plane (z), illustrates another important fact: the presence in all cases of a high acceleration component along the accelerometer's z-axis. This is unexpected since, when thinking about wheel design, focus on acceleration occurring along the x,y plane is common, even though, according to our study, a high acceleration also occurs along the wheel axis. This result can be understood by examining the area of the surfaces exposed to explosions (Figure 10 on page 76). In fact, as the acceleration is proportional to the force and the force to the surface it is applied to, multiplied by the pressure, the larger the surface, the higher the acceleration. In the case of the x and y axes, the area exposed to explosions, perpendicular to the wheel plane, highlighted in blue in Figure 10, is not much larger than the surface of the wheel perpendicular to the z-axis, highlighted in red in Figure 10. Because this surface is large and because the geometry of the wheel and the relative position of the landmine and the wheel are never symmetrical, the acceleration on the z-axis is high.

Therefore, a third general result is that, when developing wheels to dissipate the shock wave associated with an explosion, it is worth concentrating also on acceleration dissipation along the z-axis, i.e., the wheel axis.

Conclusion

The main reason for this test was choosing which wheel out of four proposed designs was the best to mount on the LOCOSTRA. A large amount of data was recorded during the test, allowing for much analyzing and deep study.

After a long data processing period, analysis and ordering to achieve consistent results, wheel n. 4 (Genoa) was adopted (Figure 11 on page 76). The main reason behind this choice is the wheel's good behavior among all evaluation criteria. In fact, although wheel n. 3 (EPR) performed similarly to wheel n. 4 at reducing the acceleration transferred to the axis, it worked worst at dissipating potential energy and at retaining mechanical integrity.

Some important general considerations can be drawn from the tests and could be used in the future to approach new research into blast-resistant wheels:

1. Predictably, the wheel entirely made of steel has little deformation and transmits little potential energy (probably due to good venting), but transmits very high accelerations.
2. Some means of dumping the force transmitted by the wheel along the z axis should be considered.
3. Inflatable inner wheels work well to absorb acceleration caused by small quantities of explosive, thanks to the large amounts of hysteresis cycles taking place into the rubber covering the inner wheel, due to the compression and expansion of the air inside (Figure 12); their ability to absorb acceleration caused by high-

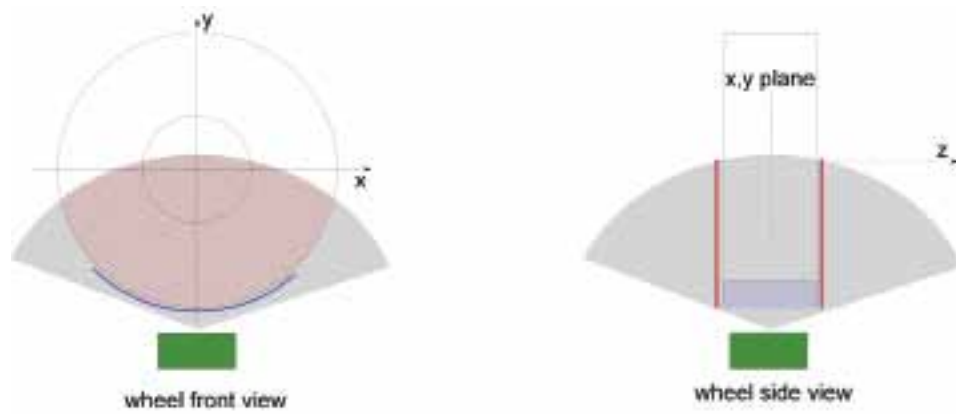


Figure 10. Wheel surfaces hit by the blast wave. Blue is the surface perpendicular to x, y plane; red is the surface perpendicular to z axis.



Figure 11. Genoa wheel after the fourth explosion. Only this last test was done on the tractor.



Figure 12. Frames taken by the high speed camera during the explosion of 120g of TNT under Florida wheel. The upper part of the wheel moved 73mm upwards in 1/50s while the axis did not move.

er quantities of explosive is compromised by the limited amount of this rubber available.

4. All wheels are made out of tank heads, drilled and adapted to host the inner wheel. It would be more sustainable to use flat surfaces, i.e., standard steel profiles, which are widely available.
5. Using an inflatable 4WD vehicle tire as the inner wheel for the wheel n. 3 is a sound idea (thanks to Andy and Ed), because these tires are widely available.
6. The best blast-resistant wheel, on the basis of this test's experience, is a wheel with a large, soft, rubber inner wheel, embedded into an outer rigid structure made of steel presenting the maximum possible number of holes to allow venting.

Profiting from lessons learned from the tests, Genoa's design has been slightly modified. Wheels that are now mounted on the LOCOSTRA machine have been developed employing flat surfaces instead of tank heads. Moreover using slightly thicker steel—6mm instead of 4mm—allowed fewer deformations. By keeping the same principle of having the solid rubber inner wheel and the steel outer part, the best compromise between optimum outer wheel diameter, maximum venting and maximum shock absorption, related to the inner solid rubber wheel diameter, has been accounted for. A test on the same pendulum used on the first wheel produced confirmed that the measuring system used during the different tests has been reliable and the new wheel design has better behavior than the original wheel n. 4 (Genoa) design. After this last test, which occurred in November 2010 in the same location as the first test, LOCOSTRA was successfully tested against live anti-personnel landmines in Jordan during February and March 2011. There, with the support of the University of Jordan, the National Committee for Demining and Rehabilitation, Norwegian People's Aid and the Geneva International Centre for Humanitarian Demining, LOCOSTRA was equipped with blast-resistant wheels designed according to lessons learned during the test described in this article, was driven over six live mines ranging from 29g of Tetryl (M14) to 240g of TNT, without registering any significant damage either on the wheels or on the machine itself. ↕

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See endnotes page 83



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2. "A Global Overview of Explosive Submunitions." *Human Rights Watch*, 21-24 May 2002. <http://tinyurl.com/3lrocsg>. Accessed 3 October 2011.

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2. Clark, Chris. "Unexploded Cluster Bombs and Sub-munitions in South Lebanon: Reality from a Field Perspective." Statement at the ICRC expert meeting on humanitarian, military, technical and legal challenges of cluster munitions. Montreux, 18-20 April 2007. M-85 submunitions are more dangerous than BLU submunitions in that although they have a lower failure rate than BLU, some M-85 have a self-destruct function that does not always work and therefore they can be accidentally detonated later. Also, "M-85 submunitions have a drag ribbon that causes the bomblet to become entangled in trees and bushes and to hang there presenting an additional hazard to farmers and specialist clearance personnel." <http://bit.ly/n9RPjm>. Accessed 3 October 2011.

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2. Wallace, Meghan. "Security Threats to Afghan Deminers." *Journal of ERW and Mine Action*. Issue 15.1 (Summer 2011). <http://tinyurl.com/3muwn2b>. Accessed 23 September 2011.

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The Information Management & Mine Action Programs, Sawyer [from page 35]

1. Often used in a military context, a common operating picture is a single display of information relevant to the operation. It improves collaboration and helps achieve situational awareness.
2. A gazetteer is a geographical dictionary, or directory, with important references for information about locations on a map or atlas.

Congolese Soldiers Learn to Combat UXO and Mines, McCarty [from page 39]

1. Component commands are commands serving in different areas (branches) of the same military agency.

Landmines in Libya, King [from page 44]

1. Pentaerythritol tetranitrate
2. Trinitrotoluene
3. Cyclotrimethylenetrinitramine
4. *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (also known as the Anti-personnel Mine Ban Convention or APMBC). <http://www.icbl.org/treaty/text/english>. Accessed 19 October 2011.

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Thailand and Compliance with the APMB: Mission Impossible ... Or a Feasible Task?, Bach [from page 51]

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Toward LOCOSTRA: Blast-Resistant Wheels Test , Cepolina, Zoppi, Belloti [from page 75]

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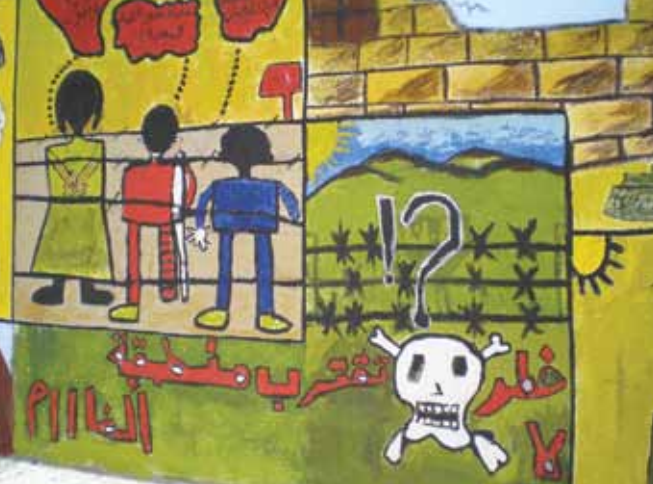
Corrections from Issue 15.2 of *The Journal of ERW and Mine Action*:

- The headshot on of Andy Smith on page 35 was incorrect.
- The wrong version of the article on page 67, LOCOSTRA: Blast-resistant Wheels Test was printed. The correct version appears in this issue.
- Corrections to these errors were made in the online version of issue 15.2.

The staff of *The Journal* apologizes for these errors.

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