Issue 17.1 | April 2013

# THE JOURNAL OF ERW AND MINE ACTION


## FOCUS: Clearance Operations Trends & Technologies

## PLUS: Notes from the Field | Research and Development

THE JOURNAL OF ERW AND MINE ACTION

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Feature: Asia & the Pacific
Special Report: Underwater UXO Detection & Clearance

Issue 17.3 | Fall 2013 (Print and Online)
Focus: Survivor Assistance
Feature: The Middle East
Special Report: Syria

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**Cover Photo**

A child stands outside a classroom at Abu Shouk Women Center in Darfur, Sudan. Women often attend classes with their children because of a lack of child care.
*Photo courtesy of UNAMID/Albert Gonzalez Farran.*

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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.**

*The Journal of ERW and Mine Action* Editorial Board reviews all articles for content and readability, and it reserves the right to edit accepted articles for readability and space, and reject articles at will. Manuscripts and photos will not be returned unless requested.

The views expressed in *The Journal of ERW and Mine Action* are those of the authors and do not necessarily reflect the views of the Center for International Stabilization and Recovery, James Madison University, the U.S. Department of State or the U.S. Army Humanitarian Demining Program.

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

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Office of Weapons Removal & Abatement

# Director's Message

(Photo courtesy of Missouri State University Photo Services)

Dear Readers,

In this issue, we present *The Journal's* subscriber survey results. Along with helpful feedback regarding future topics, article length, and print edition design and layout, we received suggestions to improve readers' online experience, which continues to be vital for *The Journal's* evolution.

Several survey participants expressed interest in having more content regarding clearance trends and technologies—conveniently, the Focus section of this issue. Articles on clearance trends note that even our most basic work must be innovative enough to incorporate efficiencies, changing technologies and best practices. In this section, for example, Åsa Gilbert and Aron Larsson reveal the results of a 2012 GICHD study that considers the effectiveness of post-clearance inspections as well as the financial costs, time and effort incurred in the execution. In addition, Gvantsa Kvinikadze of the NATO Support Agency discusses a capacity-building project in Georgia and GICHD's Pehr Lodhammar expands on the concept of land release.

The Feature section centers on gender and age issues by bringing together ideas from the field on how best to address issues of access, rights and equity. It examines these issues in post-conflict recovery and includes an article from Abigail Jones, Arianna Calza Bini and Stella Salvagni Varó about how demining activities can be improved through the integration of gender-sensitive mine risk education. Moreover, CISR's Cameron Macauley authors an article about the CISR/IBUKA peer-support program for female genocide survivors in Rwanda.

In this issue, we also highlight the retirement of Jim Lawrence after 45 years of U.S. Government service. As Director of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), Jim led innovative efforts to build public-private partnerships, advance the humanitarian mine-action agenda, and alleviate the negative impacts of weapons of war around the world. Most telling about Jim's retirement celebration, however, was the number of younger faces present in the room. He was an outstanding mentor to those who worked with and for him.

Jim Lawrence helped establish the U.S. as the world's largest contributor to worldwide mine clearance and victim assistance programs, and led the first U.S. observer team to the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and their Destruction* meetings in 2009. He brought an enlightened perspective to mine action and partnered with the private sector and civil society to clear mines and unexploded ordnance while also helping survivors on their road to recovery. By leveraging his broad international service, which includes Peace Corps volunteer service in Morocco and Fulbright fellowship work in Indonesia, he delivered resources to those working on the front lines to help make Earth a safer place for all. His friendship and leadership will be greatly missed by many around the world.

Sincerely,

Ken Rutherford

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EDITORIAL

# 2012–2013 Reader Survey Results Good News!

by Jennifer Risser [ Center for International Stabilization and Recovery ]

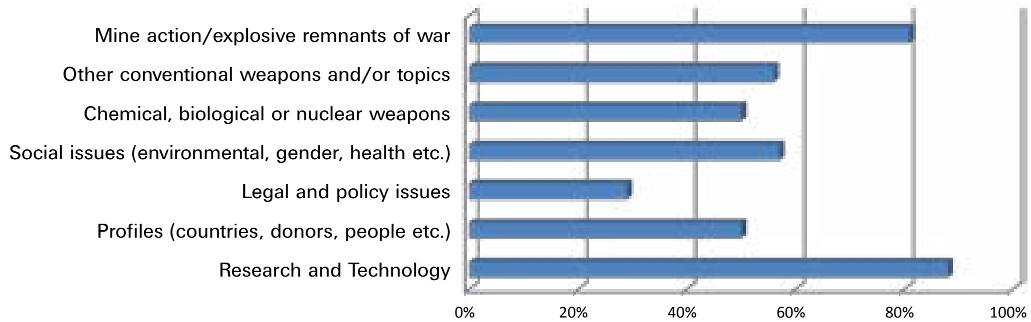


Figure 1. "Which of these *Journal* topics interest you (multiple selections acceptable)?"
*All graphics courtesy of CISR.*

*The Journal of ERW and Mine Action* thanks you, our subscribers, for sharing your opinions of our print and online publication. We received a 7.8% survey response rate—more than double the usual direct response rate! Here are a few of the highlights.

You suggested that we write about a wide range of topics; here are a few:

- Armed violence reduction
- Cluster submunitions
- Environmental issues
- Grenades, especially identification, fuze mechanisms and how they are used
- Information technology
- New sources of funding
- Open burning, open detonation
- Quality management
- Scrap metal collecting and MRE
- Small arms destruction
- Stockpile destruction
- Success stories
- Survivor assistance

Note that although *The Journal* does not currently cover chemical or biological weapons, 29% of you thought this would also be an interesting topic.

We found that most of you are happy with *The Journal* layout (98%) and agree that the content is appropriate (87%). You like the current length of articles and believe that articles should only be long enough to convey essential information (86%). We are also pleased to report that a large majority of you (94%) are happy with *The Journal's* editing process.

We received a few suggestions for improvement, which we plan to implement, beginning with Issue 17.2/ Summer 2013.

- *The Journal's* policy on acronyms will change to reflect your preference to insert acronyms after mine action terminology and organizations—explosive remnants of war (ERW), confirmed hazardous areas (CHA), etc.
- Similarly to our previous survey results, we found that most of you (77%) indicated that **Notes From the Field** is one of your favorite sections. In light of this, we will expand the Notes section and move it to a position of prominence in the publication.
- In addition, the majority of you prefer to read the **Research and Development** (79%), **Feature** (62%) and **Focus** (58%) sections, and **Country and Organization Profiles** (52%).

When asked which version of *The Journal* you prefer to access, 36% said you prefer using the print version, while

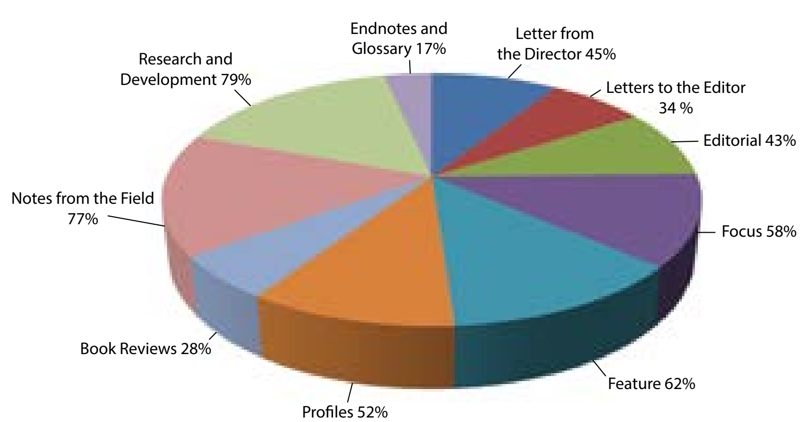


Figure 2. "Which sections in *The Journal* do you read (multiple selections acceptable)?"

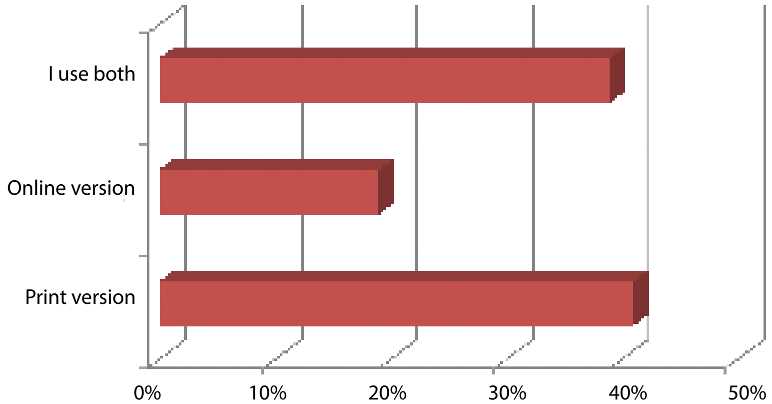


Figure 3. "Which version of *The Journal* do you access?"

41% prefer accessing both the print and online versions. Only 16% prefer the online-only version.

We received a variety of responses to the question "Why do you prefer to read the print version [of *The Journal*]?" Numerous respondents noted that "old habits die hard" and that they didn't "like to read content on the computer." Notably, readers stated

- "Easier for me to read."
- We are in a country where electricity and internet are not always available."
- "High-tech media doesn't work in low-tech countries."
- "Unfortunately our firewalls restrict access to some sites."
- "Demining is still very unfamiliar amongst my government officials. They prefer hard copies."
- "I usually read it on flights or other times when I'm not on a computer."
- "Convenient to browse and read."
- "I can take my *Journal* as a magazine with me anywhere and show it to people; it is tactile and a more friendly medium."
- "For future references and research work."
- "Convenient to browse and read."
- "Makes me read more of the articles published. *The Journal* can be easily available at an office."
- "It is easier to take with me and read when I don't have internet access."
- "I'm a traditionalist, I guess. I highlight various segments of the articles in the print version and keep them for reference purposes."

We also received constructive suggestions on how to improve readers' experience with the online version of *The Journal*. While the overwhelming majority of you (98%) felt the layout and design of the print and online versions are easy to follow, some of you offered additional feedback including:

- "The online edition does not take advantage of the added feature capability of the digital medium, i.e., links to additional information, descriptions of terms when hovering the mouse over a word."
- "You have to scroll too much."
- There are "too many navigation links. Just a PDF is easier. Put hyperlinks in the table of contents within the PDF."

**"Why would you not submit an article to an ONLINE-ONLY edition?"**

- "The hard copy is more user friendly and nice to show."
- "Not valued by my institution"
- "Much less visibility"
- "A printed version is like a living thing [while] an online version is a virtual thing."
- "Implies [the article is] not important enough for the print version."
- "If I had something interesting to write, I would like it to be of such importance that it should be in the paper version too!'

Based on these and other suggestions received, the online version of *The Journal* will implement several improvements. Primarily, a PDF of each complete issue will be made available. The PDF will have navigational links to move easily through the issue and access other online resources; and it will contain additional articles that are available online only.

The HTML version will be improved and include interactivity. The HTML version will be simplified for easier navigation and limit the need to scroll. We will include better descriptions of the topics in each issue and incorporate mouse-over definitions of uncommon words or expressions.

We will also improve the online directory of past issues to include a topic-based index of articles and work to create a mobile application and a tablet format for *The Journal*.

*The Journal* team will continue to take your suggestions to heart as we move forward with future issues. Thank you for your time and invaluable feedback!

*Note: We edited all responses for grammar, spelling and clarity purposes.*

**Jennifer Risser** joined the staff in April 2009 as assistant editor for *The Journal of ERW and Mine Action*, and became managing editor in November 2011. Previously, she worked as an editorial assistant at the Penguin Group in New York. Risser received a Master of Arts in publishing studies from City University, London, and a Bachelor of Arts in English from James Madison University.

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# PM/WRA Director Jim Lawrence Retires, Leaves a Legacy

By integrating the public and private sectors, Jim Lawrence of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) has brought energy, innovation and passion to mine action. Through anecdotes, coworkers and friends remember Lawrence and his influence on the field as he retires.

by Lois Carter Crawford [ Center for International Stabilization and Recovery ]

After serving as acting director for two years, James (Jim) F. Lawrence officially became director of the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) in May 2011. In many capacities, Lawrence was the face of U.S. Government humanitarian mine action over the past few decades.

During his retirement speech on 29 January 2013, Lawrence offered this advice: "The greatest success of a leader is to hire talented people and then watch them succeed." His influence and management style will live on in the community long after his retirement from 45 years of government service in February 2013.

"My years of watching Jim manage people were very beneficial when I switched jobs and landed in a supervisory role—I was able to use techniques I hadn't realized I had learned from him and that really built my effectiveness in my new job," says Stacy Bernard Davis, senior advisor to the U.S. Special Envoy to Monitor and Combat Anti-Semitism.[1]

H. Murphey (Murf) McCloy, Jr., senior advisor, PM/WRA (retired), agrees: "I first met Jim Lawrence back in the late 1990s when he entered the international humanitarian mine action field with the Office of the Special Representative of the President and Secretary of State for Global Humanitarian Demining [S/GHD]. For nearly 20 years I have worked both with Jim and for him, and always with the same results: I ended up smarter and wiser as a result of our professional interaction, and expanded considerably my repertoire of jokes, funny stories and tales that generally begin with 'Now you're not going to believe this, but …'"[2]

John Stevens, foreign affairs officer, PM/WRA, likes to tell a story about Lawrence's creativity and determination: "Shortly after I went to work for Jim in October 1999 when

During his retirement reception, Jim Lawrence (left) poses with Assistant Secretary of State Andrew Shapiro (right).
*Photo courtesy of the author.*

he was the deputy director for S/GHD, we traveled to Orlando, Florida [U.S.], to staff an information booth at the annual conference of social studies teachers. The centerpiece of our participation was a landmine education curriculum that we had commissioned the Center for Teaching International Relations at the University of Denver [U.S.] to prepare for us, and which we intended to distribute to teachers from around the United States, Canada and other countries.

"Obviously, we needed compelling visuals to attract folks to our booth. So we took along some U.S. Department of Defense training boards that had realistic, full-scale replicas of various landmines protruding from them. The landmine displays were too big to pack, so Jim decided that we should carry them with us on board the aircraft. Although this was pre-9/11, I had some trepidation about traipsing through National

> I have worked both with Jim and for him, and always with the same results: I ended up smarter and wiser as a result of our professional interaction, and expanded considerably my repertoire of jokes, funny stories and tales that generally begin with 'Now you're not going to believe this, but …'"
>
> ~ H. Murphey (Murf) McCloy, Jr., senior advisor, PM/WRA (retired)

Jim Lawrence and Murf McCloy with Chinese diplomats at Lake Bled during mine action meetings in Slovenia, May 2008.
*Photo courtesy of Dennis Barlow.*

Airport [Washington, D.C.] with boards bearing landmines and warning signs with skulls and cross bones.

"'Don't worry,' said Jim. 'It's not a problem. If anyone asks, we'll just show them the mines are fake.'

"When we descended from the taxi at National Airport, most travelers didn't pay attention to us, but several of the redcap porters were Eritrean immigrants. They immediately recognized the mines and the Eritrean warning signs on the boards that we had selected at random. They were thrilled! One of the men proclaimed with pride, 'I used these mines!'

"However, when we got inside the terminal, folks at the counter and the gate were less than enthusiastic, even when we flipped the signs around to show that the mines were merely extruded plastic. Fortunately, Jim's banker-like appearance and sales patter overcame their default setting of 'No way.' Jim just kept moving past them even when we were standing still. He overwhelmed them with breezy optimism: 'Aren't these great? We got them from the Department of Defense. We're going to show these to social-studies teachers, and they're going to teach kids all over the United States how the real devices are a problem around the world. Secretary of State Albright has endorsed this. We're so excited to take the message to American kids …' Everyone just looked at him with amazement, but they let us pass. When we entered the [airplane] cabin, Jim even talked the stewardess into letting him store these big panels in the suit locker. Alas, Jim returned to D.C. early. Lacking his combination of gravitas and show-biz moxie, I elected to ship the boards back to the office, and I flew back without them."[3]

"Jim is a special guy," agrees retired Col. Dennis Barlow, former director of the Center for International Stabilization and Recovery at James Madison University. "In a city [Washington, D.C.] filled with puffed-up officials and rubber-stamp bureaucrats, Jim brought dedication, energy, imagination and enthusiasm to every project every day.

"He also had a vision for increasing the effectiveness of U.S. landmine remediation efforts by somehow combining private American initiatives with U.S. Government policy," says Barlow. "While the whole initiative was fraught with bureaucratic and legal conundrums, Jim was undeterred. He would somehow find a way to leverage these two great forces, and he

As a reflection of their collegiality and shared commitment to mine action, some of the original members of the Public-Private Partnership team gather for lunch in December 2012. Left to right: Beth Schlachter, Jim Lawrence, Stacy Bernard Davis, John Stevens, Dave Rabadan.
*Photo courtesy of U.S. Department of State.*

Jim Lawrence at an August 2012 reception recognizing James Madison University fellows for the U.S. Department of State's Frasure-Kruzel-Drew Memorial Fellowship in Humanitarian Demining.
*Photo courtesy of CISR.*

did. Jim created a vibrant coordinated program—the Public-Private Partnership Program—which integrated private and government-agency actions into coherent country plans.

"The remarkable thing was that Jim did not merely authorize this program. In a one-man diplomatic barnstorming tour, he visited scores of NGOs [nongovernmental organizations], including Rotary Clubs around the world, and agencies to personally drive this project. He was literally the godfather of the Public-Private Partnership initiative, and I believe it was made possible solely by dint of his personal involvement and passion for the cause in which he believed so deeply."[4]

Jerry White, deputy assistant secretary of state, U.S. Bureau of Conflict and Stabilization Operations, says, "Jim Lawrence has been a faithful friend to landmine survivors and mine action implementers worldwide. We are grateful for his commitment to make sure humanitarian mine action incorporated all the vital elements from surveying to public awareness, victim assistance and mine risk education to clearance. Jim has been a role model of public service over the years, dedicated to advancing this humanitarian cause in very pragmatic ways. He will be deeply missed at State, but his work and legacy will go forever forward."[5]

Under the leadership of Jim Lawrence a wide range of innovative programs were developed with very interesting partners—from clearance organizations like The HALO Trust to U.S. universities like JMU and Michigan State to volunteer associations such as the Association of Volunteers in International Service. He was open to new ideas and unique solutions to landmine clearance and awareness. Some of these, such as the PPP Program that he developed and headed for years, followed the for-profit business model of networking, developing symbiotic partnerships and doing business on the golf course.

It's public servants like Jim Lawrence who make things happen and who ensure that the U.S. Government is seen in a positive light overseas by helping people recover from conflict and creating ways for stability, security and democracy to take root. His whole career, from Peace Corps through the U.S. Department of State's Bureau of Population, Refugees and Migration to PM/WRA, exemplifies his commitment to making a difference for people around the world through public service.

~ Stacy Bernard Davis,
senior advisor to the U.S. Special Envoy
to Monitor and Combat Anti-Semitism

The PPP Program allowed him to represent his office and the Department of State at fun events he enjoyed, "like a Freedom Fields USA gala at Clint Eastwood's golf club or going to the U.S. Open [tennis] on PM/WRA business," says Davis.[1]

"I learned much from Jim and, hopefully, he from me," says Donald (Pat) Patierno, president of the Board of Directors of MAG America (Mines Advisory Group) and a former State Department colleague. "I continued to learn from him after I left the Humanitarian Demining Program, mostly about the significance of engaging the private sector on such

Jim Lawrence hits his second shot at the famous 16th hole at the Pasatiempo Golf Club, Santa Cruz, California (U.S.).
*Photo courtesy of James Lawrence.*

a humanitarian effort. I learned a lot from him outside the office as well—usually on a golf course somewhere, but that is fodder for a different story."[6]

"Throughout the many years I've known Jim, he's become more than just a colleague; he is a friend and a mentor to me," says Ken Rutherford, CISR director. "My most special personal memory of our friendship occurred in 2003 on the prestigious Cypress Point golf course in Carmel Valley, California [U.S.], as guests of Clint and Dina Eastwood. Jim had helped organize and support the first Freedom Fields fundraising dinner. It generated US$150,000 for landmine removal and clearance to benefit more than 6,000 families living in the Kamrieng district of Cambodia.

"While I never golfed a full round before losing my legs to a landmine, I picked up this sport on a more or less regular basis just two years before playing with Jim. Rather than getting frustrated with my wild shots going everywhere but the fairway, he tried to coach me on golfing strategies and course management. I appreciated his guidance. In my opinion, Jim is one of the most **boring** golfers that I've ever had the pleasure of playing with. His golf shots are all the same—long and straight down the fairway. Unlike my shots that ended up in the water or sand, Jim never made a mistake. His shots landed on the fairway or green. Boring, consistently.

"Thanks, Jim, for those times you've supported landmine survivor assistance efforts and for helping a survivor pick up and play the game that you so much love. Thank you for sharing your passion for both."[7]

According to Davis, "It's public servants like Jim Lawrence who make things happen and who ensure that the U.S. Government is

Jim Lawrence receives the U.S. Secretary of State's Award for Public Outreach from Colin Powell in 2004.
*Photo courtesy of U.S. Department of State.*

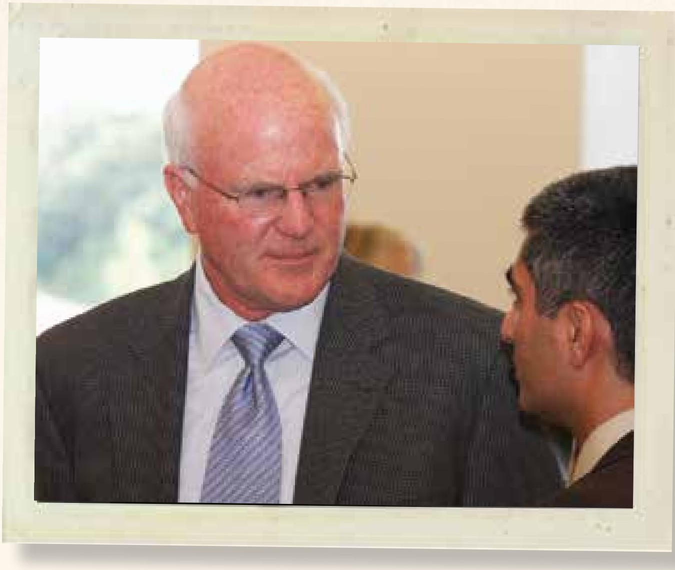
seen in a positive light overseas by helping people recover from conflict and creating ways for stability, security and democracy to take root. His whole career, from Peace Corps through the U.S. Department of State's Bureau of Population, Refugees and Migration to PM/WRA, exemplifies his commitment to making a difference for people around the world through public service."[1]

Rutherford agrees, "He is always ready to offer his support for partnering on mine action events, whether developing innovative Public-Private Partnership events in California, Florida and elsewhere, educating Americans on mines, or spending grueling hours on planes to Europe, the Middle East and South America in order to promote mine action. Jim was always there in a behind-the-scenes leadership role making everyone else look good as long as the message was on track."[7]

Innovation was one of the keys to Lawrence's success and the success of the programs he oversaw. Ralph Cwerman, president and cofounder of the Humpty Dumpty Institute, recalls, "I remember calling Jim from Kansas City, Missouri [U.S.], in 2005. I had just toured a U.S. Department of Agriculture storage facility—a vast underground cavern that housed, quite literally, billions of pounds of excess food like cheese, butter, lentils and powdered milk that would ultimately be used as U.S. foreign-aid packages. During the tour a light bulb went off: NGOs like HDI could apply for some of this food and monetize [sell] it to fund foreign agricultural-development programs. After explaining to Jim how this food could benefit mine action, he readily agreed that we should do it.

"In the days that followed, Jim and I fashioned a new program, and his office provided HDI with seed money to develop special proposals for Angola, Sri Lanka and Laos. These proposals would eventually result in more than US$15 million in new funding, nearly half of which was used for mine action. Jim's decision to invest in HDI's project development ultimately led to removing landmines and unexploded ordnance in these three countries that saved hundreds of thousands of lives, allowed farmers in Angola and Sri Lanka to grow their crops safely and bring their produce to market for the first time in 20 years, and allowed tens of thousands of young children to walk to school safely in one of the most mine-infested provinces in Laos."[8]

McCloy sums it up: "Jim's father was a retired Marine brigadier general, one of those legendary heroes that came out of the fighting in the South Pacific during World War II, and one of those leaders that, as a young Marine officer (circa 1963),



Jim Lawrence talks with Siraj Barzani, head of the Iraqi Kurdistan Mine Action Agency, at the closing dinner of CISR's 2011 Senior Managers' Course.
*Photo courtesy of JMU Photo Services.*

I was taught to emulate. As I worked with Jim over the years, I came to admire him for the same attributes that I had learned his father embodied: integrity, dedication to duty and the welfare of his people, and underpinning it all just plain old 'guts'—the desire to do the right thing no matter how hard the task or unpopular the undertaking.

"Just as Jim's father fought so courageously for the American cause and the oppressed peoples of the South Pacific during World War II, so Jim has worked tirelessly and effectively on behalf of hundreds of thousands of disadvantaged people worldwide whose lives are severely afflicted by explosive threats, the legacies of past wars. His quiet brand of leadership has been as effective in waging peace as his father's efforts were in waging war; consequently, PM/WRA and the Department of State are prepared as never before to face the evolving challenges in the fields of humanitarian demining and the destruction/disposition of MANPADS [man-portable air-defense systems] and other conventional weapons.

"As Jim departs for retirement, he leaves behind untold thousands who are fortunate to have had him for an advocate; hundreds of professional associates and coworkers who have benefitted from his leadership; and a father in heaven that is mighty proud of how his son picked up where [he] left off and went on to make the world a much better and safer place for us all. In my book, even without a horse (generally not allowed to attend State Department functions), that's one heck of a way to ride off into the golden sunset," says McCloy.[2]

"Jim served the State Department's mine action program with honor and commitment. He has adhered to a high standard of conduct, clinging to an uncompromising code of personal integrity," agrees Patierno.[6]

"While Jim may be retiring," notes Cwerman, "I suspect he will still play a critical role in advancing the cause to which he has dedicated much of his career. On behalf of all of the partners of PM/WRA, I simply say thank you, Jim, for your support, advice and friendship."[8]

*See endnotes page 64*

While Jim may be retiring, I suspect he will still play a critical role in advancing the cause to which he has dedicated much of his career. On behalf of all of the partners of PM/WRA, I simply say thank you, Jim, for your support, advice and friendship.

~ Ralph Cwerman, president and co-founder of the Humpty Dumpty Institute

**Lois Carter Crawford, APR,** is editor-in-chief of *The Journal of ERW and Mine Action* and also served as project manager on the *Adaptive Technology Catalog: Tools for Survivors of Landmines and Explosive Remnants of War* and the *To Walk the Earth in Safety* projects. Prior to joining CISR in 2005, Crawford worked in advertising and publishing for more than 25 years. She is an accredited public relations professional and holds a Bachelor of Arts in psychology from the University of Wisconsin–Milwaukee.

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FOCUS

# Building Capacity to Clear ERW in Georgia

From October 2010 to September 2012, NATO's Georgia Explosive Remnants of War and Medical Rehabilitation Partnership for Peace project provided extensive explosive ordnance disposal training to the Georgian Military Engineering Brigade and supplied needed medical rehabilitation equipment to Gori Military Hospital.

by Gvantsa Kvinikadze [ NATO Support Agency ]

Georgian soldier during demining training.
*All photos courtesy of the author.*

On 28 September 2012 the Military Engineering Brigade of the Georgian Armed Forces hosted a ceremony for soldiers from the Explosive Ordnance Disposal Company. The ceremony commemorated their successful completion of an extensive training program provided by NATO's Georgia Explosive Remnants of War and Medical Rehabilitation Partnership for Peace project (2010–2012).

The NATO PfP project grew out of an appeal by Georgia to NATO requesting assistance with clearing ERW, much of which was created during the war between Georgian and Russian forces in 2008. Georgia also faces the problem of Soviet-era legacy minefields. Therefore, forming a national capability for coping with these challenges in accordance with International Mine Action Standards seemed necessary. NATO Support Agency (NSPA) designed the project to strengthen the Georgian Army's Explosive Ordnance Disposal Company.

The project consisted of two major elements: ERW clearance support and medical rehabilitation. The Czech Republic, Estonia and Lithuania (as lead nations) largely sponsored, both politically and financially, the NATO project. Fourteen other NATO members and partners—Australia, Azerbaijan, Bulgaria, Denmark, Israel, Japan, Latvia, Norway, Poland, Romania, Spain, Turkey, the United Kingdom and the United States—made financial contributions to the project's EU€1,540,000 (US$2.1M as of 25 January 2013) budget. NSPA (previously NATO Maintenance Supply Agency), which served as the executing agent during the 2003–2006 and 2008–2012 PfP Trust Fund projects to demilitarize outdated missiles, implemented this project.[1]

In its earliest stages, NSPA tailored the project to fit Georgia's specific needs. According to David Towndrow, NSPA's project manager, the project aimed to "provide Georgia with a military capability to clear legacy minefields and free land contaminated by hazardous ammunition left over from previous conflicts, thus contributing to [the] creation of [a] safer environment and more economic opportunities for the local population.

"This goal," he adds, "would be achieved by providing specialist equipment and training based on international standards to the EOD Company of the Military Engineering Brigade."

Soldiers from the EOD Company prepare for a blast during training.

## ANAMA

Following a competitive, international bid in February 2011, the Azerbaijan National Agency for Mine Action was selected to provide the training package. In recent years, ANAMA gained clearance and training experience in Azerbaijan and in other countries. In addition, ANAMA established a comprehensive training center in Goygol, northwest Azerbaijan.

In July 2011 ANAMA completed a NATO PfP project to clear more than 600,000 unexploded ordnance items that were scattered throughout 568 ha (2.2 sq mi) of land in Saloglu, a village in Azerbaijan's Northeast region. These scattered items of UXO were the result of an explosion at the main Russian military ammunition depot in the early 1990s. Its experience clearing Soviet/Russian-manufactured UXO from Saloglu was one of the reasons why ANAMA was chosen to train Georgian EOD troops to identify specific UXO types encountered in Azerbaijan and Georgia.

Elnur Gasimov, head of ANAMA's Training, Survey and Quality Assurance Division, says, "ANAMA has 13 years' experience in humanitarian demining operations, and we have worked with the militaries of different countries, including Azerbaijan, Turkey and Syria on different types of projects. The Georgia project, which envisages providing basic as well as specialist courses and practical training, is quite complex. We believe that after this intensive training the EOD Company will be fully prepared to take the responsibility for coping with existing ERW threats and greatly benefit Georgia."

## EOD Training

Training began at the end of March 2011. All 66 members of the EOD Company completed a month-long training course that covered basic demining, EOD and battle area clearance at ANAMA's regional training center in Goygol, Azerbaijan. Following the theoretical components of the courses, students practiced hands-on clearance using inactive mines and completed EOD/BAC tasks using live munitions on a military artillery range in Saloglu. The training in Azerbaijan ended with a Technical Survey course geared toward training 15 military engineers, who were selected based

The EOD Company works with metal detectors during training.

on their performance during the basic courses as well as their future functions within the EOD Company. Courses for instruction methods, site supervision, information management and quality assurance/quality control, which did not need specialist facilities or designated training areas, were held at the soldiers' barracks in Georgia.

In order to confirm the capability of the EOD Company as an established yet independent organization, five months of mentoring in Georgia followed the comprehensive series of courses, from April to September. In this stage, ANAMA instructors provided supervision and mentorship to the EOD Company as it conducted live clearance operations at two sites designated by the Georgian Ministry of Defense. To provide the opportunity to practice different humanitarian demining skills, one site was classified as a minefield and the other as a battle area.

Acting commander of the EOD Company, Senior Lt. Mikheil Katsiashvili thinks that the mentoring phase provided an opportunity for the Company to consolidate the learned skills obtained during the training courses. Katsiashvili remarks, "I believe that the new skills provided by the NATO project will successfully build on our own extensive experience in EOD. We are looking forward to the time when we start planning and implementing the operations independently according to the humanitarian standards and contributing to the safety of our population in this way, too."

NSPA procured the basic and specialist equipment, worth EU€460,000 (US$619,574 as of 25 January 2013), that was provided to the EOD Company before the start of the mentoring phase. The list of equipment was developed in consultation with the Georgian MoD and ANAMA. It consisted of items necessary for conducting demining and EOD/BAC operations. These items included different types of personal protective equipment, mine detectors and deminer tool kits. In September 2012, under Phase II of the project, the EOD Company received three minibuses and three all-terrain, pickup vehicles, which will significantly improve its operational capabilities.

### Medical Rehabilitation

Gori Military Hospital was the sole beneficiary of the project's medical-rehabilitation element. Thanks to the generous contribution of the Czech Republic, the project's largest sponsor, Gori Military Hospital received medical equipment

Vice Prime Minister of Georgia and State Minister for European and Euro-Atlantic Integration Giorgi Baramidze (Ret), H.E. Ambassador of the Czech Republic in Georgia Ivan Jestřáb, and the Gori Military Hospital staff tour the physiotherapy department to see the new equipment.

worth EU€80,000 (US$107,752 as of 25 January 2013). This element of the plan was aimed at enhancing the capabilities of the hospital's physiotherapy department, which treats wounded military personnel and civilians. NSPA, which closely cooperated with the Czech Republic, Georgian MoD and the hospital's physiotherapy department, created the equipment list.

Nino Kervalishvili, head of the physiotherapy department at the Gori Military Hospital, appreciates the donation. She comments: "We were providing the medical-rehabilitation treatment with existing minimal technical capabilities in [the] physiotherapy department. With the installation of the new, advanced equipment purchased under the NSPA project, we now provide [a] wide range of services, like movement therapy, medical massage, hydrotherapy, etc., to the patients with various types of injuries or traumas." A closing ceremony for the medical-rehabilitation element of the project was held in June 2012.

## Success Impacts Future

Irakli Kochashvili, deputy head of the Euro-Atlantic Integration Department at the Georgian MoD notes the project's achievements: "The project is significantly different in its content from the previous two projects as it is mainly focused on capability development of the Georgian Armed Forces … GAF has obtained a unit that is capable to conduct humanitarian demining fully compliant with IMAS for the sake of very humanitarian purposes—safety and security of people."

As the ERW Clearance Support and Medical Rehabilitation project concludes, NATO and Georgia remain interested in continuing their cooperation. Thus, hopes are high that a new PfP Trust Fund project will soon follow.

*See endnotes page 64*

*The NATO website published a version of this article 18 December 2012: http://bit.ly/RC54Zs.*

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# A Review of External Post-clearance Inspection: How Cost-effective is it?

The Geneva International Centre for Humanitarian Demining conducted a study in early 2012 to consider the effectiveness of performing external post-clearance inspections. GICHD took into account the practices of the International Mine Action Standards, the International Organization for Standardization and the numerous mine action programs worldwide. It also worked with the Swedish company Preference Consulting to determine the mathematical probability of finding a mine/explosive remnant of war during external post-clearance inspections. Lastly, GICHD examined the normative effect of external post-clearance inspections as well as the financial cost associated with their execution.

by Åsa Gilbert and Aron Larsson [ Geneva International Centre for Humanitarian Demining ]

Substantial time, money and effort has been spent on external post-clearance inspection since it was first included in the International Mine Action Standards in 2000.[1] However, a recent review of the practical implementation and findings of external post-clearance inspections illustrates that nonconformity levels are minimal, which provides cause to reflect on the activity and approach itself.

In early 2012, the Geneva International Centre for Humanitarian Demining completed a study that examined the cost and benefits of this process. Through external post-clearance inspections, the study also sought to determine the level of statistical confidence in the land being free from explosive hazards after clearance.

## Quality Management in Mine Action According to IMAS

The IMAS definition of quality management is somewhat narrow when compared to the International Organization for Standardization 9000 series standard. For the purpose of the discussion, this article uses the IMAS terminology and definitions.[1,2]


Figure 1. Flow chart outlining the relationship between components of Quality Management in accordance with IMAS.
*All graphics courtesy of GICHD.*

IMAS 09.20, "The inspection of cleared land: guidelines for the use of sampling procedures," states the following:

"The aim of demining Quality Management is to provide confidence (to the beneficiary, the demining organization and the national mine action authority) that clearance and quality requirements have been met and that cleared land is indeed safe for use. Quality Management for demining comprises three complementary components."[3]

The three components are accreditation, monitoring and post-clearance inspection. According to IMAS 09.20, accreditation and monitoring are parts of quality assurance, while post-clearance inspection is a part of quality control. In humanitarian demining, QA confirms "that management practices and operational procedures for demining are appropriate, are applied correctly and will achieve the stated requirement in a safe, effective and efficient manner."[2] QC relates to the inspection of a finished product; "in the case of [humanitarian] demining, the 'product' is [safe] cleared land."[3]

The essential difference between the two is that **QA** ensures that the **processes** for demining are appropriately applied, while **QC** ensures that the **product**, i.e., the cleared land, is indeed free from mines and explosive remnants of war hazards to a specified depth. QA takes place prior to and during survey and clearance operations, while external QC generally takes place once an operator completes an agreed clearance

| | |
|---|---|
| **Internal QC** | Internal sampling of cleared areas on a daily basis by a supervisor during operator break times. |
| **External QC** | Sampling conducted during an external QA visit by an external QA officer. Normally not recorded. |
| | **Post-clearance inspection IMAS 09:20** (sampling by an external body once a site has been completed) |

Table 1. Terminology related to quality control.

task and leaves the site. IMAS uses the term **post-clearance inspection** interchangeably with **external QC**.

Usually independent monitoring organizations, tasked by national mine action authorities, implement external post-clearance inspections. However, these inspections are sometimes conducted through a contractual arrangement or by the national mine action authority itself. The inspection involves re-clearance (also known as sampling) of a certain percentage of an area that an operator already cleared. Deminers typically carry this out manually. The actual sampling occurs once an area is completed but before the land is officially handed over to the end user.

External post-clearance inspection intends to ensure that the quality of work reaches an agreed standard. In mine action, the quality standard is that the area in question is free from mines and ERW to a pre-determined depth.

Internal QC is another vital component of any organization's internal quality management system and involves post-clearance inspection performed by section/team leaders or supervisors during a break or at the end of a working day. However, this article does not cover these internal QC activities.

## Implementation of External Post-clearance Inspection

The International Campaign to Ban Landmines reports that there are approximately 50 active mine action programs throughout the world. Research has shown that 14 programs implement post-clearance inspection, more than one-quarter of all active mine action programs. The majority of countries with humanitarian mine action programs do not implement external QC processes; instead, they employ a stringent QA approach that includes accreditation of operators prior to deployment and regular inspections of survey and clearance teams during operations.

## History of QA/QC in Mine Action

Prior to 2000, no globally accepted standards were in place to measure the quality of land considered safe through survey and clearance. Nor were any agreed approaches in place to measure the appropriateness, efficiency or effectiveness of employed survey and clearance methodologies. In 2000, steps were taken to incorporate a number of the standards that focused on quality within ISO; these were later applied to the mine action sector.

At the time, ISO standards were evolving as production industries moved from a focus on QC to QA. By 2000, lessons learned from the production industries indicated that a more balanced approach to quality management was required and that QA and QC should be given a more equal status.

In 2003, IMAS 09.20 was incorporated into IMAS. IMAS 09.20 is based on ISO 2859, the standard developed for production-line processes, such as the manufacturing of car parts.[4] The application of ISO 2859 assumes that the product (in the case of demining, cleared land) is homogeneous; i.e., the product is uniform and has the same composition throughout.

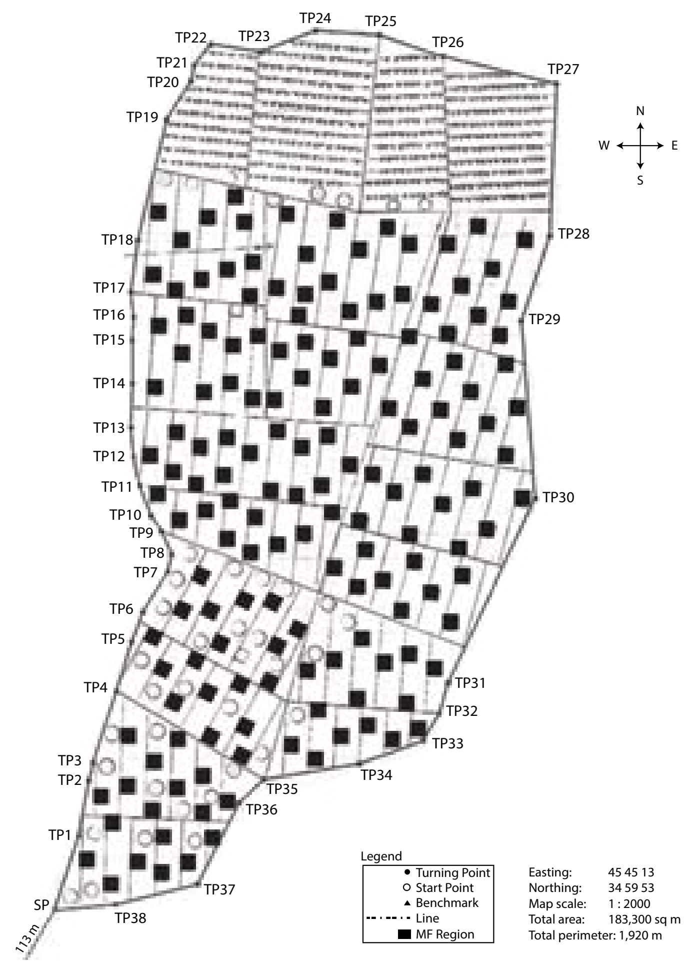


Figure 2. Example of a sampling plan for external post-clearance inspection. Each orange box represents a sample where deminers manually re-cleared the ground.

## Theoretical Review of IMAS 09.20

In the GICHD study, the analysis of the mathematical probability of finding a mine/ERW that was previously missed was carried out by Preference Consulting—a Swedish

| | Number of mines/ERW or critical nonconformities found during external QC | Sq m sampled during external QC 2010 | Estimated cost USD (million) | Critical nonconformities/mines found |
|---|---|---|---|---|
| **Country A** | 8 mines since 2004 | 635,000 | 1.06 | 1.1 |
| **Country B** | 2 noncritical nonconformities in 2010 and 5 in 2009 | 500,000 | 1.10 | 2 |
| **Country C** | last missed mine in 2003 | 2,640,000 | 2.40 | 0 |
| **Country E** | 0 mines since the beginning of sampling in 2006 | 3,260,000 | 2.97 | 0 |
| **Country F** | 3 mines since the beginning of sampling in 2006 | 14,000 | 0.06 | 0.6 |
| **TOTAL** | | **7.05 million sq m** | **USD 7.59 million** | **3.7 nonconformities/mines** |

Table 2. Statistical Summaries of Case Studies for 2010 | Summary of sampling statistics from five of the six case studies for 2010. Country D was excluded since data was not available for this period. To calculate the cost of sampling during 2010, an estimate of 0.91 USD per sq m (a comparatively low price) was used for countries C and E for which a specific value was not available. The number of critical nonconformities or mines found in 2010 included in the table are inferred from available data for countries A and F and represented as an average.

During 2010 a total of 7.05 million sq m was sampled at a cost of USD 7.59 million. Over this 12 month period 3.7 mines or critical nonconformities were discovered during the sampling activities with an average of 1.90 million sq m of land re-cleared for each mine or nonconformity found. On average USD 2.05 million were spent per mine or critical nonconformity. No data was available on whether mines were functional when discovered or whether the critical nonconformities (which contribute to more than 50 percent of the data) were missed mines/ERW or a further item such as a large piece of metal.

company with strong links to the *Kungliga Tekniska Högskolan* (KTH Royal Institute of Technology)—Stockholm University and Mid Sweden University.[5]

Preference Consulting determined that sampling plans based on ISO 2859 are not optimal for all applications and may be costly. A quantitative investigation of the sampling plans specified in IMAS indicated that sampling has a relatively high cost when the lot size is small and the quality of the clearance is high but provides only a marginal increase of confidence in clearance. Therefore, reducing the level of sampling, or in some programs, ceasing external post-clearance inspection altogether may be beneficial.

In its report, Preference Consulting showed that the quality of mine clearance maintained by the Bosnia-Herzegovina Mine Action Center was far better than that sought by IMAS, because fewer nonconformities were found in actuality than were expected and would typically be acceptable for post-clearance inspection.[4,5] As a result, any actual increase in confidence provided by sampling tended to be quite low, as the confidence in the quality of the cleared land prior to sampling was already very high.

Preference Consulting states that when conforming to IMAS procedures for the inspection of a cleared area, in the event that a lot from this area fails inspection, "… the corresponding optimal sampling plan is … not to perform sampling at all."[5]

### Normative Effect

All of the countries included in the case studies wished to continue external QC in one form or another. The given reasons rarely involved increasing confidence in the quality of the cleared land, instead focusing on external QC's normative effects on demining organizations. An operator who knows that a cleared area will be inspected post-clearance has more motivation to complete the task in a satisfactory manner as opposed to a program where no external post-clearance inspections are applied. This is known as the normative effect.

Despite this, the majority of mine action programs choose not to use external QC and instead apply a rigorous QA approach. When processes are appropriate and carried out in accordance with accredited standard operating procedures, the quality of the cleared land naturally follows.

External QC teams sample millions of square meters of cleared land, but they find very few missed mines/unexploded ordnance. An operator with a more stringent QA process could have potentially detected the majority of those found. Others were missed because the initial threat assessment was not conducted correctly.

Limited official statistics exist on the number of accidents that occur on land that has been cleared and handed back to the local population. However, the general impression within the mine action sector is that the quality of land cleared in mine action programs without external quality control is lower than that of mine action programs that employ external QC.

## Cost

The additional costs of external QC are difficult to accurately quantify. However, in two of the seven case-study countries, the annual costs were conservatively estimated at more than US$1 million per country. This was based on the average cost of clearing one square meter of ground, multiplied by the number of square meters sampled.

In 2010 the findings of the study show that 7.05 million sq m (272 sq mi) of previously cleared land in five countries was subject to re-clearance during external QC. This cost $7.59 million, yet only four mines were found, illustrating why the costs and the added value of external QC should be reconsidered. In addition to cost, the extra time and necessary resources should also be taken into account as clearance assets are diverted away from clearance activities. During field visits, external QC often added up to 10 or more days to the overall duration of a task.

## Conclusions and Recommendations

Based on the discussions held during case studies and with other stakeholders, evidence suggests that the general understanding of quality management and the systems involved are limited within the mine action sector.

IMAS and most national mine action standards provide only a fairly narrow description of the issue. This implies that the field is missing opportunities to achieve efficiency and effectiveness, as well as to learn from and improve upon past experiences.

Based on findings from the case studies (see Table 2) and the work done by Preference Consulting, the general quality of the majority of cleared areas appears to be high, and sampling provides little additional confidence as to whether a particular area is free from explosive hazards.

*See endnotes page 64*

*The GICHD study's research and report was made possible through the generous support of the government of Switzerland and through additional contributions from the governments of Norway, Sweden and Australia. The complete version of the study report is available at GICHD's website: http://tinyurl.com/cpvz487.*

**Summary of conclusions and recommendations of the GICHD report:**

- *External QC comes at a high cost but provides a negligible increase in confidence that a cleared area is in fact free from explosive hazards.*
- *The ISO-2859 may not be the optimal reference standard for mine action.*
- *Alternative sampling methodologies better suited for mine action should be explored, such as targeting of high risk areas opposed to random sampling.*
- *By emphasizing QA rather than QC, quality throughout the clearance process is ensured with little or no need for QC.*
- *Focus should be on the quality of management of the survey process rather than the clearance process.*
- *In certain situations, mine action programs may benefit from applying external QC (i.e., in areas cleared by new operators/teams or by operators with a poor track record.) Post-clearance sampling should therefore remain an option for IMAS.*

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# Legal Aspects of the Land Release Process

This article explores areas of liability in mine action operations. It defines the concept of residual risk after completion of survey and clearance efforts and presents methods of assigning responsibility for it. The author offers further legal considerations in mine action, including the extent to which contractors are liable for their equipment, employees and the cleared land both during and after operations as well as the process by which national mine action standards are incorporated into the legal liability of all concerned actors.

by Pehr Lodhammar [ Geneva International Centre for Humanitarian Demining ]

A mine action liability workshop in Colombia addresses some of the legal aspects of the land release process.
*Photo courtesy of Deywis Ayire Casas-Prensa/PAICMA.*

Although liability has concerned mine action for a number of years, only recently has the Geneva International Centre for Humanitarian Demining made a concerted effort to better understand it. The issue is very important, as it has in some cases delayed states from efficiently addressing mined areas and from meeting obligations under Article 5 of the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBC).[1]

Before survey and clearance, in the case of public land, the government normally bears the responsibility for the hazardous area and any accidents or incidents that occur. During survey and clearance, the responsibility usually falls on the organization carrying out the operation.[2]

What remains undefined is who is responsible when the operator has completed survey and clearance, and the area is handed over to the end user. Who is responsible if an accident leading to loss of life or damage of property occurs, or if a mine or explosive remnant of war is found on released land? How much of the land should be re-cleared, and who should carry out the task? Who will pay for the cost of re-clearance?

Handing back released or cancelled land from the operator to the government, end user or community is an aspect of mine action liability requiring special attention. This is because, even after land is cleared or released, a residual risk always remains—a fact that the States Parties to the APMBC, in adopting a voluntary "declaration of completion," realistically express. An explosive item may be moved into the cleared area after its handover, flooding may cause a mine's migration, or an ERW may rest beneath the required clearance depth.

### Over-clearance

The possibility of residual risk should not, however, be a reason or excuse for over-clearance—unjustified follow-up clearance behind demining machines—or the insistence of national mine action authorities on extensive external quality control. A recent GICHD study based on five countries in 2010 showed that a total of 7.05 million sq m (3 sq mi) of land was sampled at a cost of US$7.59 million, and only four mines/critical nonconformities were found.[3] This research indicates that although the cost of external quality control is considerable, the added confidence that the land is free from explosive hazards post-clearance is negligible.

However, GICHD mechanical demining experts often witness follow-on clearance being carried out behind well-proven and tested demining machines. This is despite no audible or visual detonations, or any other evidence of mines during the mechanical intervention. Why is this? Is this for reasons of liability rather than achieving high quality clearance?

If mine action standards are detailed, and national standards are followed during clearance and based on a well-implemented tasking system with a quality management system in place, the operator is not liable following the handover of released areas. Individual occurrences can always be viewed on a case-by-case basis, if evidence shows the operator is negligent. In general, the government should assume responsibility for the released areas and should have standards for victim compensation and for how to deal with residual risk.

### Mine Action Standards

The International Mine Action Standards are guidelines for the safe and efficient management of mine action operations, as well as a framework for the development of national mine action standards and standard operating procedures.[4] IMAS have no legal standing, except where a national authority has adopted them as binding instruments, or where one or more of the standards is specified in a contract or other legal instrument.

National mine action programs should be based on IMAS and adapted to fit each country's existing hazards, conditions, climate and terrain. NMAS must also align to existing regulations, standards and legislation. Examples of such existing legislation include but are not limited to

- Labor law
- Public procurement law
- Rules for handling and storage of explosives
- Regulations governing building permits and land use
- Rules for handling information
- Protection of the environment

National standards should be developed through a consultative process, where all stakeholders in the country are involved and agree on what is possible and desirable. As part of this process, agreement on terminology and interpretation of wording is important. For example, what is "all reasonable effort" in the context of land release? This might be interpreted differently, depending on the operator.

Establishing what kind of status NMAS will be given is also important. Will they be adopted under national legislation with legal status, or will they remain a set of unlegislated standards? Will a specific mine action law be written in which NMAS are referenced? This should be defined clearly.

Based on GICHD studies, the general recommendations are as follows:

- There must be clear standards and procedures for handing over land cleared or released through Technical or Non-technical Survey.
- The exact point in time when liability transfers from the organization conducting the survey and clearance to the government should be specified.
- All documentation from involved parties must be included in NMAS, such as
  - » The handover certificate
  - » Maps of areas surveyed, including cleared areas and areas cancelled or released through Non-technical Survey and Technical Survey
  - » Methods used and clearance depth
  - » Documentation explaining the reasons why areas were cancelled without technical intervention and the basis for these decisions
  - » Evidence indicating the agreement of local authorities, land users and any others involved in the decision to release specified land uncleared
  - » Copies of internal and external quality assurance reports
  - » Documentation of any quality control measures undertaken

Ensuring that the entire process is documented and that documentation is safeguarded is critical. All technical aspects of a demining operation should be recorded, and it is crucial that any decisions leading to all or part of the land being deemed safe from explosive hazards through survey activities be carefully documented. To correctly do this difficult task

- National standards must describe how to deal with any residual risk.
- National standards must outline how and for how long documentation is stored (this should be aligned with national legislation for handling and storage of information and treaty reporting requirements).

*... even after land is cleared or released, a residual risk always remains.*


Mechanical demining as part of the land release process.
*Photo courtesy of the author.*

- The government should take responsibility for all areas deemed safe through clearance and survey once these areas are handed over.

## Practical and Cost-effective Ways of Dealing with Residual Risk Liability

A well-functioning quality management system provides transparency, third-party objectivity and a minimum level of quality in handing land back to the local population. If applied correctly, it also reduces the residual risk and clarifies liability issues.

Following the completion and handover of land, only some of the possibilities are practical and cost-effective. These include

- **Strict liability of the state.** This seems to be the easiest and most cost-effective option, where the state takes responsibility for any claims and/or costs arising from any missed items causing residual risk. The state would also be in a better position than land owners or victims to pursue a claim against the operator, should there be any evidence of possible negligence.
- **Shared liability between the state and the operator**. The state takes the responsibility, but shares it with the operator, who, in turn, has insurance to cover the associated risks. This liability insurance is likely to be expensive.
- **The operator remains liable for a limited period, following task completion.** This can be for a period between one and five years. However, research indicates there may be some difficulties in obtaining insurance coverage beyond three years. This insurance is also likely to be expensive.
- **The quality assurance contractor assumes the responsibility** for the cleared land through insurance

coverage, when both clearance and QA are contracted. This could be an option during seismic surveys, as a part of oil and gas exploration for example, where the land is handed over to the state only at a later stage, and the QA contractor carries the responsibility until such time.

### Further Legal Questions

Today, demining work is mainly carried out through contracts. There are three main parties whose interests are fundamental behind any contract: the contracting agency, the contractor and the community. Typically, contracts will be prepared by a contracting agency seeking specialist contractors to conduct demining work. The main aims of a contract are to

- Ensure the organization responsible for day-to-day events is accountable for the consequences of their activities
- Protect the contracting agency from any claims or financial losses which may arise out of such activities

In addition to imposing responsibilities on the contractor, the contract will normally incorporate minimum levels of insurance to be provided in support of such responsibilities. However, the contract also should consider how the actual procurement action will be undertaken and what rules and legislation govern this activity. In most countries, public procurement law is obligatory, despite having been developed for civil engineering or similar work and not explicitly for demining. In some countries, specific mine action laws were developed and adapted to incorporate the particular requirements of mine action. In all cases, existing laws must be considered and followed.

GICHD also recommends that issues regarding land rights, including third-party liability, be included in the tendering process and, if possible, in the contracting process. Other recommendations are

- Statements of work in contracts should clearly include land rights considerations and actions required, as well as reporting mandates.
- Decisions about using survey and clearance assets should take into consideration the expected future use of the land.

Another important legal consideration that accreditation standards should clearly articulate is **insurance**. It is important to carefully review coverage and exclusions under insurance policies, particularly regarding the period of coverage, replacement of damaged or stolen demining machines and other equipment, and employer and third-party risk and liability. Questions to ask include:

- What are the required levels of insurance coverage?
- Does the policy purchased actually provide the coverage perceived and required?
- Should professional indemnity insurance for operators be required?

Many additional legal considerations should be taken into account. What are the national authority's current mandates and responsibilities, and how were they given to the authority? Was the authority formed through a decree, and what does this include? Where and how does the authority fit into existing governmental structures? How can we be sure there is no duplication of efforts or ambiguity regarding the various governmental bodies and their respective responsibilities and roles?

GICHD is committed to carrying out further studies and developing findings and recommendations on the legal issues affecting mine action.

*See endnotes page 64*

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*A well-functioning quality management system provides transparency, third party objectivity and a minimum level of quality in handing land back to the local population.*

# Minesweepers: Towards a Landmine-Free Egypt, a Humanitarian Demining Robotic Competition

Listed as one of the most contaminated countries in the world, Egypt has an estimated 22.7 million landmines and other explosive remnants of war.[1] In order to foster the research, development and application of robotics in humanitarian demining in Egypt, the Institute of Electrical and Electronics Engineers Robotics and Automation Society – Egypt Chapter organized **Minesweepers: Towards a Landmine-Free Egypt**, an outdoor robotic competition hosted by the German University in Cairo from 15–17 September 2012.[2]

by Dr. Alaa Khamis [ IEEE Robotics and Automation Society – Egypt Chapter ]

The majority of Egypt's landmine contamination is a result of military action during World War II, although ordnance remains from armed conflicts with Israel in 1956, 1967 and 1973.[3] Landmine contamination hinders the economic development of oil and agriculturally rich locations in the Gulf of Suez, North Coast and Red Sea areas. Furthermore, landmines emplaced in fields and around wells and water sources severely limit agricultural production, one of the mainstays of the economy, making these lands unusable and perilous. Egypt's current clearance methods, including conventional hand-held metal detectors, magnetometers and ground-penetrating radar, are slow and inefficient. It is unlikely these methods will ever achieve the required objectives that more advanced robotic solutions for minefield reconnaissance and mapping can meet.

## Environmental Clearance Challenges

The extent of contamination is unknown, but the amount of affected land is estimated at nearly 25,000 sq km (9,653 sq mi) with areas between the Quattara depression and Alamein and near Marsa Matrough and Sallum being particularly affected.[1,3] Landmines and unexploded ordnance in the region are as much as 60 years old, and contamination involves hundreds of types of landmines. Mines can have metal, plastic,

Conventional manual landmine detection methods.
*Executive Secretariat for the Demining and Development of the North West Coast.*

Competition arena with buried and surface mines.
*Photo courtesy of Minesweepers: Towards a Landmine-Free Egypt Organizing Committee.*

wood or even football casings. Furthermore, casings and components degrade over time, altering their detection signature and creating uncertainty as to how mines will withstand clearance. Additionally, thick deposits of mud or sand cover many landmines and UXO, rendering conventional detection techniques mostly ineffective.

Egypt's various soil types contribute to clearance challenges. In sandy soil, the fine grit rapidly deteriorates equipment. Wind-blown sand buries mines and fragments up to 2 m (2.2 yd) below the surface. Conventional methods struggle to detect deeply buried mines (more than 30 cm/12 in), and mechanical clearance equipment may miss them. Moreover, excavating and sifting soil for mine-size objects is more difficult in hard clay soil or rocky areas found in Egypt. Some soils also have high mineral content, which interferes with standard detection equipment. In addition, muddy areas and marshes cause particular difficulties for deminers, as standing in the mud is often impossible. Many contaminated zones reside in areas of rough terrain with steep inclines, ditches and culverts, making the movement of individual deminers or mechanical equipment around sites difficult and even dangerous.

Additionally, the climate is extremely challenging for deminers. Common temperatures reach 55 C (131 F). The lack of consistently accurate maps means that the exact location of minefields and placement of specific mines are unavailable for deminers. Available maps are copies made by the British Defense Ministry from a few surviving historical documents and can only be relied upon with a limited level of confidence, because time and weather often shift the location of mines in the soil.

On the other hand, robotic systems can be designed to provide efficient, reliable, adaptive and cost-effective solutions for landmines and UXO contamination.[4] The robotics competition, **Minesweepers: Towards a Landmine-Free Egypt**, was created to foster the application of robotics in humanitarian demining and to raise public awareness of the role of science and technology in solving this problem.

### Minesweepers Competition

Held in September 2012, **Minesweepers** is the first national robotic competition on humanitarian demining. Each participating team (maximum of 10 members) must construct a teleoperated or autonomous, unmanned, ground/aerial vehicle able to detect and map underground anti-personnel mines. The robot is required to navigate through rough terrain that mimics real minefields. The competition arena is an open, 20-by-20-m (22-by-22 yd) desert area surrounded by a 30-cm (12-in) wall. The landmine-contaminated zones in the arena start 50 cm (20 in) from each border. Most of the arena is composed of sandy soil or is rocky with obstacles, steep inclines and ditches.

This competition uses two different kinds of artificial mines.

**Buried mines.** Made from metallic cubes with approximate dimensions of 10-by-10-by-10 cm (4-by-4-by-4 in), these mines are completely buried to a depth of 10 cm (4 in). These buried metallic cubes mimic real AP blast mines. Real AP blast mines are designed to be small, typically 6–14 cm (2.4–5.5 in) in diameter, as this makes them cheap to produce and easy to store, carry and deploy.

**Surface mines.** Labeled in gray, surface mines are made from metallic cubes. These mines are visible, located on the surface of the competition area.

Any contact the robot has with these mines is penalized. The gray metallic cubes are used to simulate above-ground mines and UXO. Although UXO fail to function as intended, sometimes the slightest disturbance causes detonation. UXO vary greatly, ranging from the size of hand grenades to the size of large aircraft bombs.

For this first edition of the competition, only metal mines were considered because most mines in Egypt are encased in metal. Plans are underway to consider objects with plastic, glass or wooden casings for the next year's competition.

Some landmines are laid in a pattern so that they are easier to remove and account for; others are scattered randomly

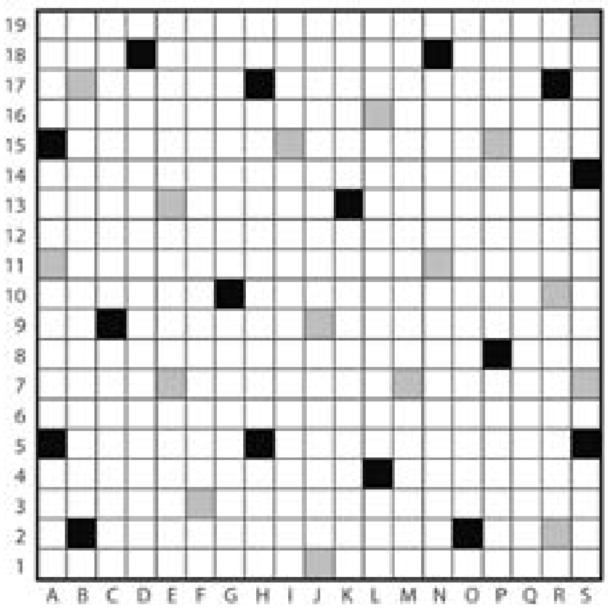


Figure 1: Graphical representation of the mine map (black = buried mine; gray = surface mine)
*Figure courtesy of the author.*

to reflect the various ways mines are found in real-world situations. Only the jury committee knows the locations of each landmine.

Each team must use a teleoperated or autonomous robot. Team members must create the robot and operate it remotely from a base station located outside the minefield. A wireless controller based on ZigBee, a set of communication protocols, is recommended for communication between the base station and the robot due to the field's large size. The robot locomotion systems require careful attention, as the terrain is particularly rough. Autonomous robots, which operate without any human intervention, receive a 40 percent bonus over teleoperated robots.

Each team can select its own set of sensors for locating mines. Although teams can install cameras on robots or on the sides of the field, no cameras or sensors are allowed to hang over the competition area. When a robot detects a mine, it must autonomously report this event using a blinking light signal and/or a warning siren for at least two seconds. The robot must also visualize and relay the type and position of the detected mine on the minefield map. Each demining robot has to provide a map of the detected mines when its competition time slot finishes.

The objective of the **Minesweepers** competition is twofold. The first objective is to create technical challenges that will generate new research and applications for robotics in the area of humanitarian demining. The second is to provide an educational forum to teach different aspects related to service robots and their application in humanitarian demining through a set of webinars and a free intensive course on how to build a real robot. Technical support is provided through a compilation of frequently asked questions, a resource page on the competition website, emails and social media network groups such as Facebook and Twitter.

The competition was judged by a committee made up of Dr. Salaheldin Omar, chair of Talent and Technology Creativity Unit at the University of Tabuk, Saudi Arabia; Dr. Hisham El-Sherif, head of the Industrial Automation Department at the German University in Cairo; Dr. Ahmed El-Mogy, an assistant professor at Tanta University, Egypt; and Marwa Soudi, Women and Junior Activities chair at IEEE Robotics and Automation Society, Egypt Chapter.

## Results

Seventy teams began at the start of the competition, but only 24 could actually compete due to various issues that arose during robot construction. While some of the teams managed to build a working robot for the competition, some quit and could not complete their robot because of limited time, lack of necessary components or a last-minute technical difficulty with their robot. Each team had 10 members ranging in age from 14 to 28 years old. The first three winners received monetary prizes and certificates of honor. EMAR from Ain Shams University in Cairo, Egypt, won first place; Pegasus from the Arab Academy for Science, Technology and Maritime Transport in Cairo, Egypt won second place and third place went to Cateus from Mansoura University, Egypt.

The author created a comprehensive questionnaire and held discussions with participants to learn the most beneficial aspects of the competition. Some of the findings indicated that

- Creating a competitive technical challenge and raising awareness about humanitarian demining in Egypt were the most important reasons the teams gave for participating in the competition.
- The respondents believe robots will be widely used in humanitarian demining in the future.
- The majority of respondents found that the competition increased their interest in robotics and humanitarian demining.
- The respondents found that the competition helped them improve their practical skills and hands-on experience. Robot design is highly interdisciplinary, and necessary skills include engineering design, mechanical engineering, electrical engineering, computer science, sensor technology, systems engineering, project management, teamwork and creative problem-solving.
- The competition helped the participants practice

EMAR, a four-wheeled unmanned ground vehicle placed first in the competition. *Photo courtesy of EMAR.*

challenging aspects of landmine and UXO detection and removal, such as difficult terrain that requires careful attention to the design of the robot's locomotion system. The harsh climate also requires the use of high tolerance and rigid electronic components. Many robots failed during the competition due to the use of traditional room-temperature electronics.

- The participants discovered that minefields are frequently strewn with small metal fragments, which can camouflage landmines and cause high rates of false positives. Therefore, participants had to put more emphasis on the ability of the detection system to differentiate subsurface mines, surface mines and randomly scattered metal fragments. The participants agreed that the competition's most challenging aspect was the mine mapping, as this process requires accurate localization of the robot in order to accurately visualize and report detected mines on the minefield map.
- The respondents expressed their interest in participating or recommending the competition to colleagues.

This year, the competition will be changed into an international competition under the title **Minesweepers: Towards a Landmine-Free World** where students/researchers from all over the world will be invited to participate. The ultimate goal of the **Minesweepers: Towards a Landmine-Free World** competition is to serve as an educational opportunity and research forum to provide efficient, reliable, adaptive and cost-effective solutions to help countries combat landmines and UXO contamination. The competition can also motivate the participants to create new companies and industries geared toward minefield reconnaissance and mapping technologies.

*See endnotes page 64*

*The author wishes to express gratitude to the German University in Cairo for supporting and hosting the* ***Minesweepers: Towards a Landmine-Free Egypt*** *competition. He also acknowledges the support and generous input of the Executive Secretariat for the Demining and Development of the North West Coast, the Ministry of International Cooperation, Mine Action and Human Rights Foundation, and Protection of Armaments and Consequences. Finally, the author would like to thank all members of the organizing and jury committee, supporting organizations and the international advisory board.*

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# How to Improve Demining Activities Through Gender-sensitive Mine Risk Education

Until recently, mine action was widely perceived as a military and technical field where an almost exclusively male staff planned and implemented activities. However, there is still a need for a better understanding of what mine-affected communities can gain from including gender and age perspectives in mine action and how the different pillars of mine action mutually improve the quality and impact of mine action programs.

by Abigail Jones, Arianna Calza Bini and Stella Salvagni Varó [ Gender and Mine Action Programme ]

MRE at a school in Juba, South Sudan, 2008.
*Photo courtesy of Åsa Massleberg.*

Communities like to feel involved in the landmine action process, including the decision-making and priority-setting processes. The consultation and involvement of women, girls, boys and men at all stages of the mine risk education project cycle helps to facilitate this process, particularly during survey and clearance activities. Current MRE processes do not always adequately incorporate community liaison and information sharing about demining activities. By systematically keeping all stakeholders informed of local demining initiatives, any questions and misconceptions can be answered and clarified. Gender-sensitive MRE is a fundamental part of the mine action process and is integral to improving the effectiveness and impact of other demining activities.

### Why Gender Matters in MRE

Landmines/explosive remnants of war pose a significant threat to the lives, well-being and socioeconomic development of communities in many countries worldwide. This threat affects people in different ways. Within a community, individuals often have distinct gendered roles and responsibilities, and consequently their exposure to and knowledge of mine/ERW risks will differ. For this reason, their MRE needs will vary, and this must be taken into account at all stages of the project cycle.

MRE contributes to risk reduction of physical injury from mines and ERW. Gender-sensitive MRE ensures that all community members are aware of the risks from mines/ERW and are encouraged to behave in ways that reduce the risk to people, property and the environment. The overall objective is to reduce the risk level so that women, girls, boys and men can all live safely and social development can occur free from the constraints imposed by landmine contamination. In support of this, the 2010 Cartagena Action Plan explicitly called for a gender-sensitive approach, suggesting that States Parties must "[p]rovide mine risk reduction and education programmes, as part of broader risk assessment and reduction activities targeting the most at-risk populations, which are age-appropriate and

A female teacher trained as an MRE facilitator carries out a session with her class in Bolomba, Democratic Republic of the Congo, 2012.
*Photo courtesy of Abigail Jones.*

gender-sensitive, coherent with applicable national and international standards, tailored to the needs of mine-affected communities and integrated into ongoing mine action activities, in particular data gathering, clearance and victim assistance as appropriate."[1]

### General Mine Action Assessment

Claims suggest that "the single biggest weakness of MRE is that projects are too often planned and implemented without an adequate assessment of needs and existing capacities. Experience has shown that assumptions about who is at risk and why this is so are frequently wrong. The consequence is that the targets and strategy of an MRE project are therefore also probably wrong …"[2] Conducting a comprehensive MRE needs assessment is essential to identify and analyze the local mine/ERW risks and to assess the capacities and vulnerabilities of the women, girls, boys and men in affected communities. These must be recognized and taken into consideration to identify the most appropriate options for conducting MRE in ways that are not only nondiscriminatory and inclusive but also more efficient, professional and sustainable in nature.

In the broader context of mine risk reduction, the information gathered as part of the MRE needs assessment is directly linked to the general mine action assessment. The collected data is instrumental for operational planning, resource prioritization and the subsequent deployment of mine action resources in areas with the greatest need. Due to the high cost of technical survey and clearance, it is more cost effective for demining actors to invest heavily in the initial data-gathering phase and in the identification of community preferences for clearance. This ensures the accumulation of high-quality data for analysis and task prioritization.

The significance of this is that data for MRE needs assessments should always be collected and analyzed as part of the general mine action assessment and in conjunction with other mine action implementing organizations. This requires a systematic gender analysis of needs in the field as well as of the balance of women's and men's voices in consultations at all decision-making levels. At the community level, mine action personnel must actively seek input from individuals representing all gender and age groups in each mine affected community. This widespread input allows personnel to obtain comprehensive and accurate information for identifying MRE needs and also community preferences to influence prioritization of clearance tasks. Consultation with the full range of stakeholders increases the quality and relevance of information gathered, which can be used to make decisions on targeted MRE as well as the cancellation, reduction or clearance of suspected hazardous areas and confirmed hazardous areas.

### Measures to Improve MRE

When certain tasks are prioritized for clearance, the allocation of scarce resources to one purpose means fewer resources available for others. Where available funding for mine action is insufficient to conduct technical survey and clearance on all reported SHAs and CHAs, task prioritization means that some areas remain contaminated due to lack of funding. In this context, gender-sensitive MRE can be used strategically to facilitate risk reduction by raising awareness of threats and teaching how to mitigate risks. Special consideration must be given to accessing all the different groups in the community because a fundamental principle underpinning MRE is that all affected people have a right to receive accurate and timely information about local landmine risks and other hazards. The following measures should be taken to overcome questions of access to mine risk reduction activities:

**Collect and analyze sex- and age-disaggregated data on distinct at-risk behaviors and attitudes.** Sex- and age-disaggregated data (SADD) is an essential part of gender analysis, which should be carried out at all stages of the MRE project cycle. It ensures that MRE providers understand and respond to the different male and female vulnerabilities, needs and access to services.[3] The United Nations *Gender Guidelines for Mine Action Programmes* explicitly points out the significance of collecting SADD, recommending to "collect and analyze data and information that reveal the distinct attitudes held by women, girls, boys and men with regards to landmine/ERW risks and threats."[4]

**Hire and train female and male MRE trainers.** In some countries, male mine action teams struggle to access women and girls to obtain their information regarding contamination and land use. Not consulting with the female community members can result in some valuable information not being taken into consideration in the planning process. One straightforward and effective solution is to have gender-balanced teams, enabling the organizations to liaise with and collect information from all ages and genders. Because pre-existing attitudes among teams can have a direct impact on data collection and MRE practices in the field, training survey/clearance teams to consider gender and recommending best practices in data collection and communication with both sexes is essential.

**Conduct sex- and age-segregated MRE sessions when needed to ensure meaningful female participation.** Participatory methodologies tend to traditionally focus on communities as homogenous entities with singular interests. However, viewing a community in this way obscures the differing interests of the social groups and does not acknowledge their varying MRE needs. Therefore mine action actors must consult with females and males of diverse age groups as part of the MRE needs assessment. They should also conduct gender-

An MRE facilitator with his class in Afghanistan, 2007.
*Photo courtesy of OMAR.*

and age-targeted activities to facilitate discussion and develop an accurate and inclusive understanding of mine/ERW risks and the correct behaviors that community members must adopt to prevent accidents.

**Ensure MRE meetings are held at times and locations that are appropriate for and accessible to women and men.** The division of labor between women, men, boys and girls means that mine action actors must devise creative and proactive efforts to ensure that MRE activities reach all stakeholders in a community. This necessitates conducting meetings at times and locations conducive to the participation of all community members in separate or mixed groups, depending on the local context.

**Use easy-to-understand gender-sensitive MRE awareness-raising materials**. MRE material should include photos of both genders. Multiple audio and visual media (drama, poster, video, radio, television) should address illiteracy and/or mobility restrictions. Furthermore, it is important to critically assess the methods used to convey the MRE safety messages. Sex and age highly influence the literacy rate in many countries. Songs, role plays and dramas can be very effective nondiscriminatory means of communicating safety messages while encouraging participation.

Designing and producing relevant MRE material is essential for effective awareness activities. The material should reflect the local culture and traditions, and women, girls, boys and men should be able to identify with scenarios portrayed by the material. Age- and sex-specific activities need to be highlighted, as different activities result in distinct exposures to risks. For example, in some cultures boys will be more exposed to the danger of mines because they have greater freedom to play or conduct other activities away from where they live, whereas girls and women are encouraged to remain closer to the home. For instance, women and girls gathering water from a river will have knowledge of different areas than men who hunt in the forests.

**Track SADD on MRE attendance.** Mine action organizations must disaggregate all data collected during MRE by sex and age. This will help to provide a clear indication and social analysis of the knowledge, attitudes, practices and beliefs that put community members at risk from mines or ERW, while indicating who is reached by MRE and the effectiveness of different techniques.

## Conclusion

The nature of MRE has changed radically since its inception as **mine awareness** in Afghanistan during the late 1980s when projects were largely based on the distribution of leaflets and posters and information dissemination tended to be one-way, with the "experts" providing information to the "unaware." It is now generally accepted that nonparticipatory projects like these should be restricted to emergency situations where conflict is ongoing, such as the current situation in Syria.

In other countries, for instance Cambodia, where people have been living with the residual effects of ERW for many years, the delivery of effective MRE is more complex. This is because local populations are often better informed about local mine/ERW threats than experts, and civilians are frequently forced by poverty to take intentional risks for economic reasons. Behavioral decisions such as these are affected by cultural, social, political and economic factors. Consequently mine action organizations are required to broaden their focus to include an examination of structural factors and local perceptions of risk held by all stakeholders.

In this context community liaison support of demining activities can provide a powerful mechanism for involving key community stakeholders in developing their own solutions, enabling them to change their behavior to reduce the risk of mine/ERW injury. The consultation and involvement of women, girls, boys and men at all stages will ensure that mine action actors can plan activities to meet the mine risk reduction needs of all stakeholders. This is not a process without challenges, as in many cultural contexts access to women and girls is difficult and literacy levels can vary significantly, meaning that for MRE to be successful, targeted interventions for each segment of the population must be designed and implemented.

*See endnotes page 64*

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# Post-conflict Recovery: Gender and Age Issues

Despite improvements in victim assistance programs, injured survivors of landmines/explosive remnants of war still struggle to obtain health care and employment. Differentiating between the age and gender of survivors will enable service providers to identify socioeconomic needs.

by Stella Salvagni Varó and Cira Hamo [ Gender and Mine Action Programme ]

A survivor works in a body of water, despite obstacles.
*Photo courtesy of Sean Sutton/MAG (Mines Advisory Group).*

The *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBC) requires that "[e]ach State Party in a position to do so shall provide assistance for the care and rehabilitation, and social and economic reintegration, of mine victims and for mine awareness programs."[1] Furthermore, during the 2004 Nairobi Summit (First Review Conference of the APMBC) concrete actions for victim assistance were included, and the term **victim** was broadened to include the injured person's family and community.[2] According to the Cartagena Action Plan adopted at the APMBC's Second Review Conference in December 2009, "States Parties are resolved to provide adequate age- and gender-sensitive assistance to mine victims, …" and several of the actions related to victim assistance (23–33) include gender considerations, namely Actions 25, 29, 30 and 31.[3] The Vientiane Action Plan adopted in November 2010 at the *Convention on Cluster Munitions* First Meeting of States Parties in Laos also includes a section on victim assistance, stating in an even more decisive way than the Cartagena Action Plan that "States Parties with cluster munitions victims in areas under their jurisdiction or control will: …" carry out a series of actions (Articles 20 through 29).[4] The recently adopted CCM officially broadens the definition of victims (Article 2) to include not only the persons directly impacted by cluster munitions (mainly men and boys) but also affected families and communities, which includes caregivers (often women and girls).

### Sex- and Age-disaggregated Data and Victim Assistance

Gender and age issues in post-conflict recovery affect the ability of men, women, boys and girls to seek and obtain assistance after trauma or injury from war or an explosive remnant of war. These issues also affect the employability of people in post-conflict situations. Landmines and ERW affect men, women, boys and girls differently, and each needs to be addressed differently. Therefore, all data for landmine/ERW accidents should be collected and analyzed in a sex- and age-disaggregated manner and separated throughout the analysis phase in order to identify the best means of assistance. The U.N. *Gender Guidelines for Mine Action Programmes* explicitly points out the significance of collecting sex- and age-disaggregated data (SADD), recommending that national mine action authorities and mine action organizations "collect and analyze data and information that reveal the distinct attitudes held by men, women, boys and girls with regards to landmine/ERW risks and threats."[5]

Both the Cartagena and the Vientiane Action Plans specify the need to collect SADD.[6] However, in spite of this, recent studies show that gender- and age-sensitive victim assistance national plans and their implementation in mine-affected countries remain insufficient.[5]

The collection, analysis and use of SADD provides quantitative statistical information on the different roles, responsibilities, mobility patterns and risks, and enables organizations providing victim assistance to better identify and understand the different needs and priorities of all survivors and indirect victims. It also helps to distinguish access to and control over resources, labor patterns, the status of rights and the distribution of benefits among the different affected groups, which is essential when planning activities for post-conflict recovery. SADD provides a clear indication and social analysis of an accident's impact on survivors and indirect victims so that a response can be tailored accordingly. In this context, mine action organizations in post-conflict situations and national mine action authorities should take gender and age issues into consideration, which will enable them to analyze the impact of landmine/ERW accidents on all community members.

### The Effects of Gender on Assistance

How does gender affect the ability of men, women, boys and girls to seek and obtain assistance following an injury from ERW or traumatic war injury? Where gender details are known, males tend to comprise the vast majority of all casualties, whereas females account for a much lower percentage. As of June 2010, the Information Management System for Mine Action SADD for landmine/ERW victims in South Sudan clearly indicated "a gendered pattern. Data collected from the ten states [in South Sudan] shows that out of a total number of 2,762 mines and unexploded ordnance (UXO) victims, 2,240 were male, 419 were female and 103 were 'unknown.'"[7] Recognizing that most landmine/ERW victims are male allows mine action programs to develop an analysis of at-risk activities.

Finding ways to adapt to disabilities allows survivors to work.
*Photo courtesy of International Committee of the Red Cross.*

Estimates indicate that females are the minority of direct landmine/ERW victims. Examples from several countries—Afghanistan, Cambodia, Uganda, Vietnam and Yemen—show that compared to men, females injured by landmines/ERW are less likely to have access to immediate health care and are therefore more likely to die from serious injuries.[10,11,12,13,14] Conversely, developing a full understanding of the situation where SADD is unavailable is impossible. As a result, this data must be included on all data-collection forms relating to accidents or landmine/ERW victims.

### Age, Gender and Employability

The APMBC mandates that each State Party in a position to do so shall provide assistance for the care, rehabilitation, and socioeconomic reintegration of mine victims and for mine awareness programs. In post-conflict areas employment

Income-generating activities are important for reintegrating landmine victims.
*Photo courtesy of International Committee of the Red Cross/Jessica Barry.*

is essential for the social status and economic empowerment of survivors and indirect victims. However, in many cases victim assistance providers do not adequately address the employability of landmine/ERW survivors, even though it is a priority for those affected.

The survivors and indirect victims highlight the issue of employability, as in a case study from Sudan (now Sudan and South Sudan), where interviewees were asked to rank their needs in order of importance and placed employment and economic empowerment after basic education for survivors and their children.[15] According to a Handicap International survey in Iraq, 95 percent of respondents said that "unemployment was so high that survivors were the last to be chosen for a job."[16] Overall, the situation for survivors is better in northern Iraq, in the more stable area of Iraqi Kurdistan. Also, the government of Iraq reportedly "does not employ persons with disabilities," and many are not admitted to schools.[16] In Jordan, evidence shows that a high level of survivor unemployment persists as well as "minimal systematic approaches to economic empowerment after landmines injury."[16]

Female survivors and victims are even less likely to find work or receive financial support and are more exposed to the risk of increased poverty. As highlighted in a study on Colombian female victims, women are often unaware of their rights regarding labor laws or property rights, as well as victim assistance entitlements like economic support or psychological assistance.[17] This lack of awareness may be related to low levels of literacy among women and girls in many affected areas. Child survivors also face specific discrimination. Teachers and classmates are often unaware of disability issues; for child survivors this often leads to "… discrimination, isolation and the inability to participate in certain activities. This is a de-motivating factor for child survivors to stay in school. As a result, education rates among child survivors are lower, while school dropouts are more frequent, which results in diminished employment prospects later on."[14]

Addressing employability issues involves tackling socioeconomic reintegration generally and approaching it as part of the post-conflict reconstruction process. SADD provides important quantitative and qualitative statistical information on the differences and inequalities between men, women, boys and girls. When collected and analyzed, SADD enables national mine action authorities and mine action organizations to recognize these differences and prioritize the needs of survivors and indirectly associated victims, as well as design appropriate services.

## Summary

SADD enables organizations to understand the full impact of landmines/ERW on male and female survivors and/or indirect victims, making it an integral part of data-collection forms. As a result, mine action groups should use SADD when planning programs designed to meet victim assistance needs.

*See endnotes page 64*


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# Women After the Rwandan Genocide: Making the Most of Survival

Since 2009, IBUKA's peer-support program for genocide survivors in Rwanda has given observers a unique opportunity to work with women who experienced the violence of 1994. In 2010 James Madison University's Center for International Stabilization and Recovery began providing technical assistance for this program. This article describes some of the particular characteristics of women survivors in the 19 years since the genocide.

by Cameron Macauley [ Center for International Stabilization and Recovery ]

Of the estimated 800,000 Rwandans killed during the 100-day Rwandan genocide in 1994, official Rwandan government figures indicate that around 56.4 percent were men. However, in many communities the proportion of men was much higher.[1,2] The reasons for this are complex, and there is much speculation on the influence of culture, history and human nature on the selection of victims.[3] Many women survived only as captives, subjected to rape and torture, while others were permitted to go free. Moreover, Tutsi reprisals against Hutus in the months after the genocide (in which more than 60,000 people died) also targeted males, and in the years after the violence thousands of Hutu men were imprisoned.[1,4] Following the genocide, the majority of Rwandan men were dead, incarcerated or living in refugee camps outside the country.[5] In some parts of the country, up to 80 percent of the population was female.[6]

What this meant in practical terms was that the Tutsi population in Rwanda—and indeed many Hutu families as well—became dependent on women to lead rebuilding efforts. With so many widows and unmarried women heading households (up to 34 percent of all Rwandan households in 2003 according to one estimate, compared with 25 percent prior to the genocide), some communities were now under the leadership of women who had, only months before, occupied a secondary status in Rwandan society.[7,8]

With that abrupt shift, many other values and priorities were soon permanently altered, in particular those relevant to child care, education and nutrition. Health care services, returning from widespread devastation, now had to focus on gynecological exams and obstetrics for the 20,000 newly pregnant rape survivors. HIV prevalence in the population took a steep jump, and as many as 175,000 of these new patients were Tutsi rape victims. Therefore, HIV clinics were treating predominately women.[9]

Since 2009, a peer-support program for genocide survivors in Rwanda has given observers a unique opportunity to work with women who experienced the violence of the Rwandan genocide in 1994. Since 2010, the Center for International Stabilization and Recovery at James Madison University has provided technical assistance for this program.
*All photos courtesy of CISR/Cameron Macauley.*

Traditional cultural restrictions on women working in certain occupations, having access to bank accounts and owning or inheriting land were largely abandoned, as women were now in charge of agriculture, commerce, transportation and even construction.[10] In 2008, 45 out of 80 members of the Chamber of Deputies were women, and the 25-seat Senate had nine women.[11] Women currently hold nine cabinet positions including those for commerce, agriculture, infrastructure and foreign affairs.[12] The government recently passed laws allowing women to inherit land and household assets, and to seek

Of the estimated 800,000 Rwandans killed during the 1994 genocide, official Rwandan government figures indicate that around 56.4 percent were men. After the war, parts of the country were up to 80 percent female. Many Tutsi and Hutu families in Rwanda became dependent on women to lead rebuilding efforts.

redress for domestic violence.[13,14] Breaking with pre-genocide social taboos, women have been elected mayors and can join the police force.[15]

### Women and Reconciliation in Rwanda

CISR and its partner organization, IBUKA (Rwanda's largest organization for genocide survivors whose name means "never forget" in Kinyarwanda), encountered women who emphasized that events in the years following the genocide revived agonizing memories of what everyone had survived. The psychological trauma sustained in Rwanda was universal—everyone was affected. Yet for women, that trauma was in some ways profoundly different, and their response to it took on some particularly female characteristics.

Numerous studies suggest that women are far more likely to suffer from severe psychological reactions to a traumatic experience than men, although the reasons for this are not all biological.[16,17] Survivors who witness the death of their own children—widely considered to be among the most severe of all traumatic experiences—have a high incidence of post-traumatic stress disorder symptoms.[18] The inability to prevent these deaths often led to years of guilt, self-recrimination and sometimes suicide.[19]

Female genocide survivors were also likely raped; between 250,000 and 500,000 Rwandan women were raped between April and July of 1994, and many of these women were subjected to sexual torture that focused on their femininity.[5,20,21] Few men were held captive or sexually abused. The psychological trauma of female survivors in Rwanda was intertwined with their identity as women, wives and mothers. It also shaped their recovery patterns.

In post-conflict Rwanda, women in female-headed households work and raise children simultaneously, making collective child care a necessity in many communities. Elderly women and pre-adolescent girls are traditionally responsible for child care. Young and middle-aged women participate in agriculture and sell fresh produce in local markets.[22] The large percentage of households now headed by women meant that collective child care had to become more systematic, incorporating mechanisms for cooking for, feeding and safeguarding the health of the children. As a result, Hutu and Tutsi women began to cooperate: By 1997, Rwanda had more than 15,000 grassroots women's organizations and 50 national associations for women, most of them multi-ethnic.[23]

### Humanizing the Other

Women harbored as much bitterness and hatred of the other ethnic group as their male counterparts. However, many Rwandan women have stepped back from the ethnic divide by arguing that genocidal violence was mainly perpetrated by

The psychological trauma sustained in Rwanda was universal. Yet for women, that trauma was in some ways profoundly different, and their response to it assumed some particularly female characteristics

males. Although some instances of female *genocidaires* occurred (a few have even been prosecuted), women generally did not participate in the slaughter. Some Hutu women sheltered Tutsis and saved their lives.[20,24,25,26]

Theorists studying reconciliation in post-conflict settings have argued that dehumanization makes it easier for us to kill our opponents.[27] Rwanda is often used as an example of the effects of dehumanizing behavior: In the months prior to the genocide, hate propaganda portrayed Tutsis as cockroaches and argued that they deserved to die.[1] The opposite strategy is used to bring former enemies together: Humanize the other side by portraying them as people just like yourself, full of love, hope and kindness, and deserving of respect. The women who cooperated in child care and peer support related to each other as mothers, wives, widows and single mothers facing the same grief and the stresses of heading a household. "We are women above all—this is what brings us together," said Charlotte Karikwera, a peer-support trainer in Kamonyi.

Rwandan women tend to distance themselves from the ethnic divisions that led to the genocide: "Ethnicity is part of a man's heritage—it is something he will strive to defend. Women see beyond ethnicity; they put the needs of their children first," said Clarisse Nzabonimpa, a Rwandan teacher who participated in CISR's peer-support training in Rwamamanga last year. "Women understand the importance of raising children in a stable, safe environment, and for most women organized violence is incomprehensible."

Thirty women currently participate in the peer-support program operated by IBUKA. They emphasize helping other women deal with traumatic memories and encourage a positive cultural shift, away from ethnic division and violence, and toward a socialization of harmony. This means remembering the horror of the genocide as a point-blank lesson on what happens if people do not live constructively. For these women who deal with heartache and grief on a daily basis, that cultural shift involves the men as well as the next generation. "It takes a terrible event to change our way of thinking," says Adelite Mukamana, a genocide survivor and IBUKA's director of psychosocial programs. "The lessons learned in Rwanda will stay with us for centuries. We could not forget even if we tried. Our goal is to reject violence as social policy and replace it with a fundamental respect for others. It is the only way to create a secure future for us all."

*See endnotes page 65*

**Cameron Macauley,** MPH, joined CISR in August 2010 as its peer-support and trauma-rehabilitation specialist. He holds a Master of Public Health as well as degrees in anthropology and psychology, and became a physician assistant in 1983. He has worked in a refugee camp on the Thai-Cambodian border, at a district hospital in Sumatra, as a Peace Corps volunteer in Guinea-Bissau, in Mozambique where he taught trauma surgery for landmine injuries, in an immunization program in Angola and in a malaria-control program in Brazil. Between 2005 and 2010, he taught mental health courses for Survivor Corps in Bosnia and Herzegovina, Colombia, El Salvador, Ethiopia, Jordan and Vietnam.

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NOTES FROM THE FIELD

# Munitions Risk Education in Cambodia

Contamination from landmines and unexploded ordnance in Cambodia poses a serious threat to citizens and impedes economic progress. The Cambodian Mine Action Centre's Mine/UXO Awareness Programme focuses on educating citizens and refugees on landmine and explosive remnants of war safety. CMAC, together with other organizations, also implements the Community Based Mine/UXO Risk Reduction Project, a program that emphasizes community participation with mine action services.

by Sambath Chan [ Cambodia Mine Action Centre ]

After three decades of conflict, Cambodia has among the highest levels of explosive remnants of war and landmine contamination in the world. The vast majority of the mine contamination occurred after Vietnam invaded Cambodia in 1978, helping to overthrow Pol Pot's Khmer Rouge regime. The Khmer Rouge troops were forced to the border of Thailand and Cambodia, and the Cambodian and Vietnamese governments laid mines in an effort to prevent them from re-entering the country. Shortly thereafter, the K5 belt, a heavily mined strip of land ranging from 10 to 150 m (11 to 164 yd) wide and 700 km (435 mi) long was created to seal off the Thai border.[1] After Vietnamese forces withdrew from Cambodia in 1989, guerrilla groups scattered landmines for short-term defensive purposes throughout the country. In addition to the millions of landmines under the ground's surface, from 4 October 1965 to 15 August 1973, the United States dropped more than an estimated 2.8 tons of ordnance on Cambodia.[2]

This mine/ERW contamination continues to maim and kill Cambodians on an almost daily basis and is one of the main factors hindering socioeconoic reconstruction and development in Cambodia. Poverty remains widespread throughout Cambodia, especially among the rural farming communities.[3] Clearance efforts are instrumental to help re-establish infrastructure; assist environmental preservation activities; allow access to resources; free land for productive use and facilitate integration of the many refugees, internally displaced, poor and landless persons.

### Cambodia's Contamination

The National Level One Survey, jointly conducted from late 2000 to April 2002 by the Cambodian Mine Action Centre and Geo-Spatial (an international consulting company) and funded by the Canadian government, revealed the following statistics:

- 6,416 Cambodian villages were identified as contaminated, or 46.1 percent of total villages in Cambodia.
- 4,544.4 sq km (1,754.60 sq mi) of land area was contaminated, which left 45.2 percent of Cambodians (5.1 million people) at risk.
- 11,429 explosive ordnance disposal tasks were initially identified. However, CMAC has responded to 65,397 EOD calls from 2006 to June 2012.[4,5]

### Cambodia's Mine Incidents

Despite the significant reduction in landmine/ERW incidents over the last decade, the number of casualties in Cambodia remains one of the highest in the world. The overall number of people killed, injured or disabled was 64,121 as of June 2012, according to the Cambodian Mine/ERW Victim Information System.[5] CMVIS further breaks down these statistics, revealing that 19,641 (30.63 percent) people were killed, 35,590 (55.50 percent) injured and 8,890 (13.86 percent) needed amputations after incidents.[5]

Cambodia's rapid population growth, estimated at 1.68 percent, increases the pressure on available safe land for housing and farming.[6] A report provided by CMVIS in June 2012 outlined that 44 percent of landmine casualties occur in villages and farms due to livelihood activities. Roads, agricultural land and community areas, such as schools, pagodas and water sources, are often contaminated, making access dangerous and preventing development. Local populations under economic pressure frequently resettle on contaminated land, increasing the number of victims.

In contrast, nearly half of ERW casualties (45 percent) result from deliberate tampering, when people try to move

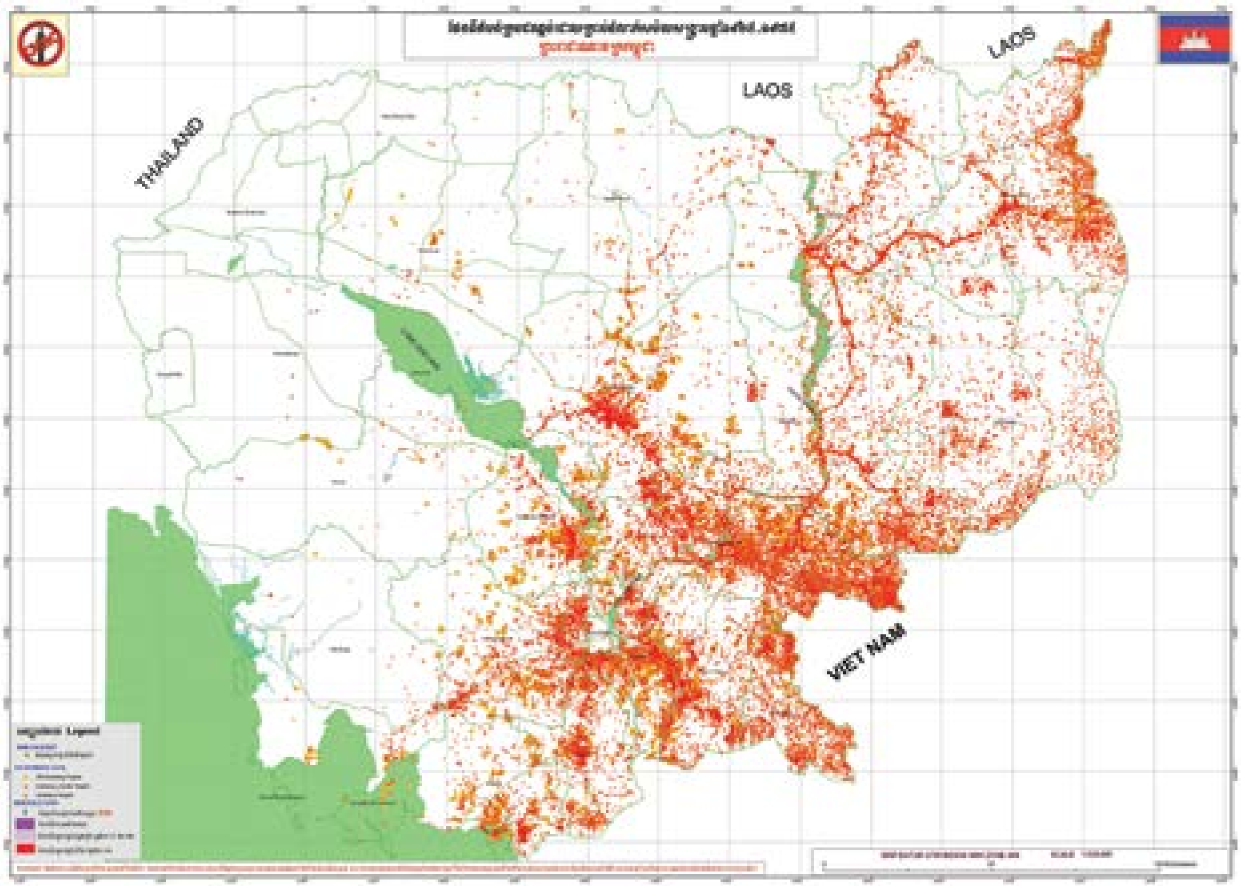


Figure 1. Map showing contamination from U.S. bombing in Cambodia during the Vietnam War.[7]
*All graphics courtesy of CMAC.*

| | Landmines | Land Ordnance | Air Ordnance |
|---|---|---|---|
| **Western Cambodia** | High | Medium | Low |
| **Eastern Cambodia** | Low | Medium | High |

Table 1. Mine/ERW threat assessment matrix.

unexploded ordnance and it detonates. Despite CMAC and other operators conducting a constant and persuasive ERW awareness campaign, villagers—including those who are not necessarily poor—and ex-soldiers attempt to sell ERW shells after removing explosives and detonators, tempted by the lucrative price of scrap metal.

### Evolution of MRE in Cambodia

Mine/ERW awareness activities began in Cambodia in 1993. Initial activities focused on returnees and internally displaced persons who often settled in heavily contaminated areas. Roaming educational teams gave presentations in villages on identifying ERW and safe behaviors.

In early 2001, CMAC, Handicap International Belgium, UNICEF and other members of Cambodia's Mine Awareness Working Group began developing a new approach to mine awareness in Cambodia. The idea was that the number of mine and ERW casualties would decrease by enabling people to live more safely in contaminated environments through a community-based, multi-disciplinary approach to mine action. These actors developed a project framework which formed the basis for the CMAC Community Based Mine/UXO Risk Reduction project. The CMBRR project seeks to integrate and link mine and UXO clearance, minefield marking, mine awareness, mine victim assistance and development initiatives with communities living in contaminated areas. CMAC implemented the project in October 2001 with technical assistance from HIB and funding from UNICEF. From the beginning, the CMBRR project has a phase-out strategy. In communities with minimal mine threat, the project has ended, although the volunteers stay trained and vigilant for future threats. Volunteers continue working in towns with a high mine/UXO risk.

The CBMRR project works to develop the willingness of communities to interact with other mine action components and to ensure that these mine action components are

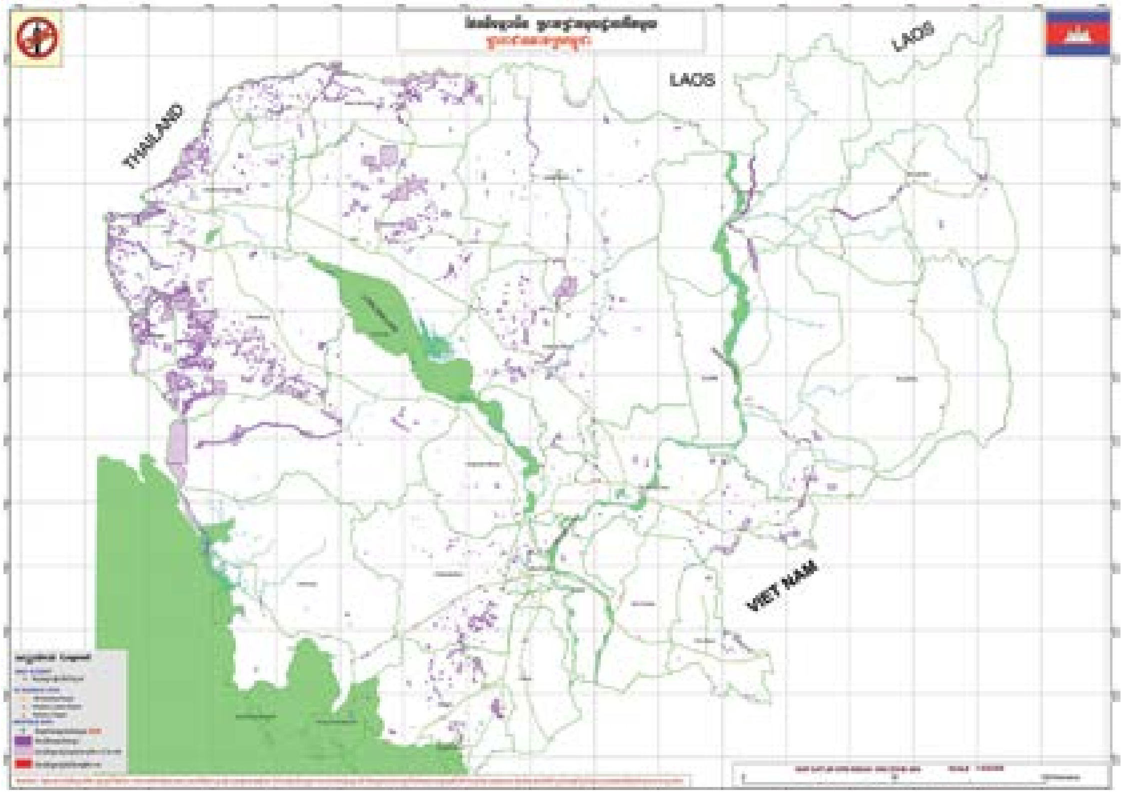


Figure 2. Level 1 Survey.

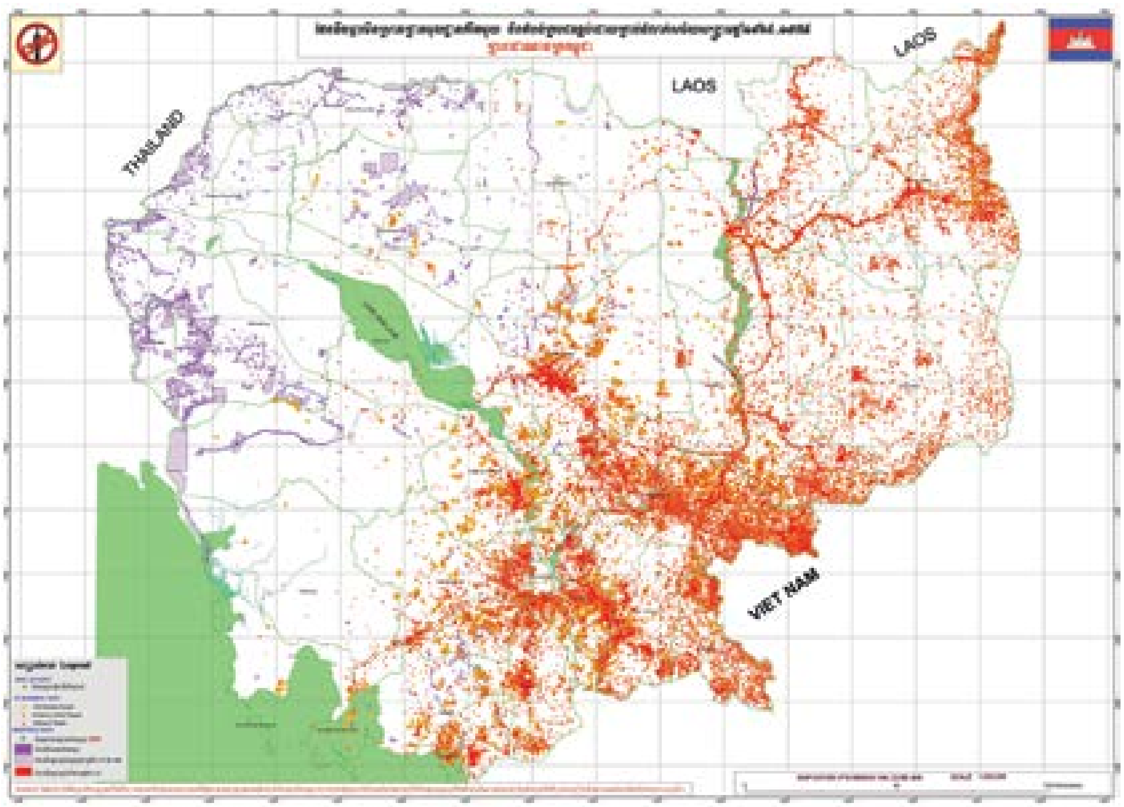


Figure 3. Map showing results of Level 1 Survey and contamination from U.S. bombing during the Vietnam War.

Communities do village mapping to identify and prioritize mine risks and accident areas in the Malay district, Banteay Meanchey province, Cambodia (25 June 2009). *Photo courtesy of the author.*

responsive to community requests. Local people in target areas are mobilized to become focal points for mine/UXO problems in their communities through the establishment of Mine/UXO Committees at village, commune and district levels. At the same time, the CBMRR project establishes links with community development projects to assist high-risk individuals, groups or communities with victim assistance projects. Mobile Mine Awareness Teams continue disseminating mine awareness messages to a wider audience. Also, an ongoing mass-media campaign primarily focuses on mine risk reduction education.

The CBMRR Project

- Is integrated with other activities and institutions involved in victim assistance, mine action and socioeconomic development
- Employs the most appropriate mine awareness and community training and liaison methods for different target groups and target areas, institutions and communities
- Targets the most heavily mine-contaminated areas
- Serves the basic needs of the most vulnerable groups

### Ongoing Efforts

The CBMRR project was quite successful, with 1,519,950 people receiving MRE during 28,176 village visits from January 2007 to July 2012.[8] Measuring the complete effectiveness of the campaign is difficult due to the risk-avoidant nature of the work and other factors involved, but the number of annual casualties in Cambodia dropped from 826 in 2001 (when the project began) to 211 in 2011.[5,6] In 2011 alone, 460 victims and their families in 354 villages accessed support services from provincial rehabilitation services. Development activities, such as the construction of community infrastructure and agricultural expansion activities, took place in 288 contaminated villages with support from CBMRR networks. These support services focus on victim assistance with regards to physical rehabilitation, medical care and social reintegration. Such services are normally difficult for people living in remote areas to access due to transportation and financial reasons. In 2011, 1,307 persons with disabilities received support services from the government. The development activities seek to improve the lives of those in landmine-affected areas. To date, 11,927 m (7.4 mi) of farm roads, 12 primary school buildings, 24 open wells and seven community ponds were built in the 288 contaminated villages. These activities have helped the communities to better utilize the cleared land and to improve their agricultural production and livelihoods.

Over the next five years CMAC will continue refining, strengthening and expanding the CBMRR project. CMAC's five-year strategy (2010–2014) is committed to expanding the CBMRR project to all Cambodian districts, seeking to educate and empower all ERW-affected communities.

*See endnotes page 66*

**Sambath Chan**, CMAC's MRE coordinator, has worked at CMAC since 2002. In addition to his current position, he has served in many capacities at CMAC in the past decade: as a community specialist, quality-development trainer, organizer of a community-based demining pilot project and project manager.

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# Catholic Relief Services Develops MRE Materials

Since its formation in 1943, Catholic Relief Services has followed their mission to help impoverished and disadvantaged people overseas. This article discusses how CRS successfully implemented a mine risk education project that has decreased the number of incidents involving landmines and explosive remnants of war in heavily contaminated districts of Vietnam. As a direct result of the project, CRS's MRE curriculum has been accepted by the provincial Department of Education and integrated with primary level public school curricula.

by Ta Thi Hai Yen [ Catholic Relief Services ]

Three decades after the end of the Vietnam War, many Vietnamese provinces continue to suffer from the consequences of landmines and explosive remnants of war.[1] Quang Tri province, located on the North Central coast of Vietnam, is one of the most heavily contaminated areas in the country. Responding to the need unexploded ordnance and mine risk education, Catholic Relief Services initiated an MRE project for children in primary school in early 2001. At the time of development, official MRE textbooks were unavailable in Vietnam.

CRS employed seven writers, including five education experts from the Ministry of Education and Training and the Vietnam National Institute of Educational Sciences, as well as two experts from the Education and Training Department of Quang Tri province, to develop and write relevant MRE materials. Writers were chosen based on their experience and expertise in the following areas:

- Development of materials for the primary school age level
- Activity-based methodology
- Participatory development of materials
- Teacher training experience

Although UXO contamination is an extensive problem in Vietnam, MRE remains undeveloped. To increase awareness, the selected writers participated in an MRE workshop conducted by Barbara Lewis, an international consultant from World Education's UXO Survivor program in Laos. UXO education in Laos is extensive and was developed based on international MRE standards. The workshop provided the writers with knowledge about landmine/UXO issues in Indochinese countries, the history of the UXO Awareness Education (Consortium/Lao PDR) textbooks and their underlying methodology, and international guidelines for UXO and ERW materials. The CRS writers used the previously mentioned list specifically for developing MRE materials. The workshop provided an MRE model—developed and tested in Laos—and international guidelines that should be followed during the process of developing materials. The assessment in Quang Tri province provided increased understanding of the landmine/UXO problem and its impact on the affected areas.

In addition to the workshop, the writers visited Quang Tri province for three days. They met with different authorities at the commune, district and provincial levels; visited schools and local households; and were exposed to the province's UXO problem and its unique personal, social and economic impact on the area. These visits increased awareness by exposing the writers to the reality of the current situation and were critical to the development of appropriate and internationally recognized materials.

### MRE Primary School Curriculum

From December 2001 to March 2002, the writing team, with the support and coordination of CRS, developed MRE materials. These MRE materials target all children between the ages of six and 12, who are currently in grades 1–5. The degree of difficulty and complexity of the MRE materials increase at each grade level. The materials are activity-based, heavily illustrated and are relayed by teachers through storytelling and brainstorming exercises. The stories and content within the MRE materials are tailored to reflect real-life instances within the different towns and villages. The materials are based on the following five principles:

**General knowledge of landmines/UXO.** The teachers instruct children on general information about landmines and


Figure 1: Map of U.S. bombing data in Vietnam and Laos.
*Figure courtesy of author/CISR.*

UXO. All MRE messages are concise, instructive and written so that children may easily read and understand them. This information includes common shapes and sizes of landmines/UXO and information about the danger posed by old, rusty ordnance even years after a war. Primary schoolchildren are not taught to specifically identify landmines/UXO, because they are naturally curious and the desire to identify ordnance may cause them to purposely get close to or touch them.

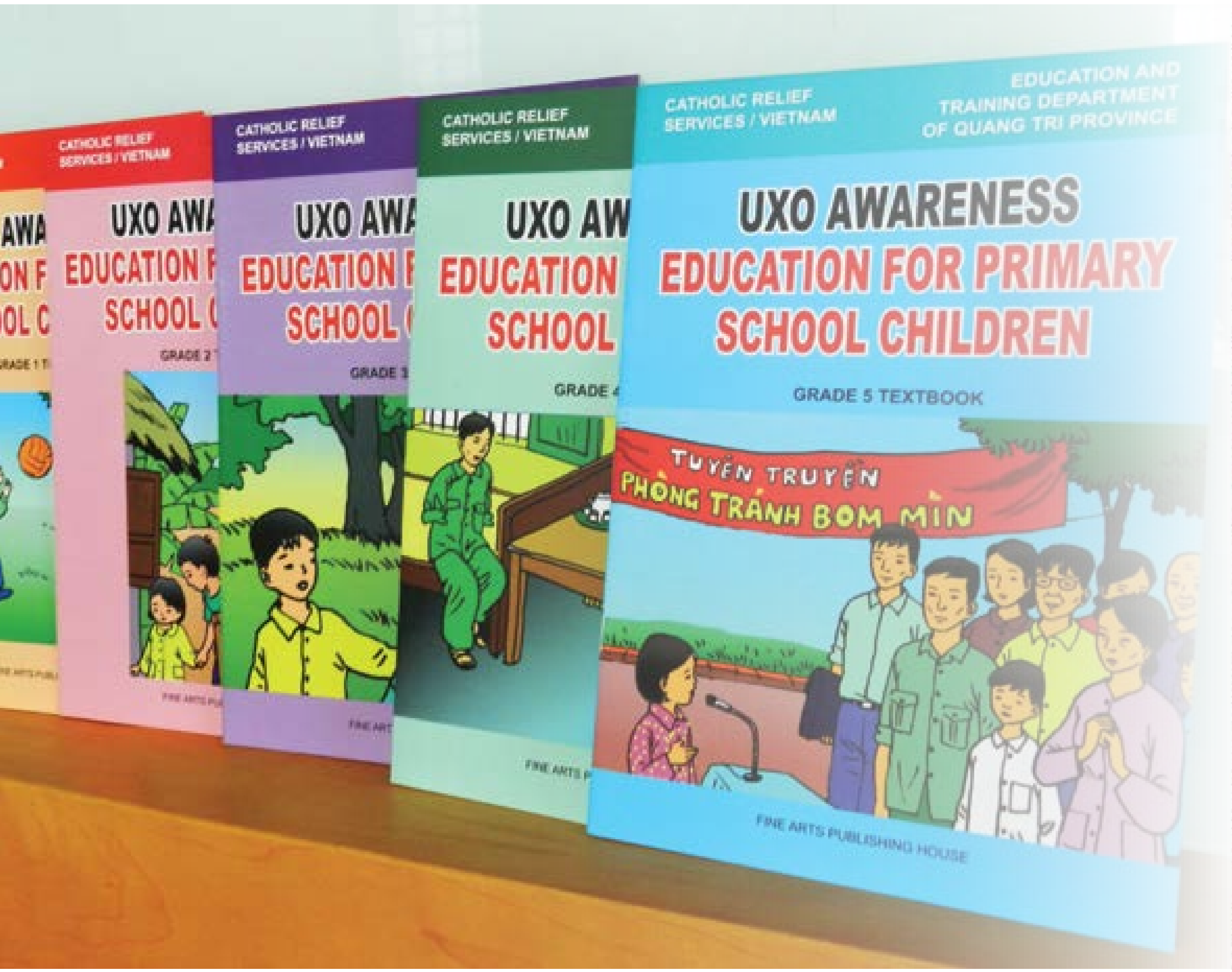
**Incidents**. The teachers educate children on specific actions that can result in an incident. These actions include touching, kicking or throwing stones at ordnance and/or attempting to dismantle landmines/UXO. Swimming in craters or entering areas designated with warning signs can also be very dangerous. In addition, building fires directly on the ground could trigger an explosion, because some UXO are heat-sensitive.

**Prevention**. To prevent incidents, teachers instruct children not to touch ordnance they find. They teach them to remember where they found the ordnance in relation to its surrounding area and to alert an adult (teacher, parent or police) of the location.

**Implications of incidents**. The provided MRE materials describe the physical, mental and social effects a landmine/UXO victim may suffer. Incidents not only affect the injured but also their families and communities. With this information, children better understand the severity of incidents and the importance of prevention.

**Disability sensitivity.** The MRE materials also address appropriate behavior toward persons with disabilities. Included in the materials are stories of how UXO survivors overcame injuries to become contributing members of their communities.

Using these MRE materials, CRS-Vietnam has provided MRE in Quang Tri province since 2001, in Quang Binh province since 2007 and in Quang Nam province since 2010. The Office of Weapons Removal and Abatement in the U.S.




A set of five MRE textbooks produced by CRS.
*Photo courtesy of Nguyen Thi Huong Thuy/CRS.*

Department of State's Bureau of Political-Military Affairs (PM/WRA) began funding the program in 2006, allowing it to expand into additional high-risk areas. CRS trained a cumulative total of more than 43,475 children and 66,464 teachers, parents and community members in eight districts, which contributed to a declining rate of landmine/UXO casualties in targeted areas.[2] School-based MRE was introduced at the primary level and successfully improved child awareness and behavior. Behavioral changes and fewer casualties were documented through evaluations, post-testing and data gathered by participating communities.[3]

The CRS primary-school MRE curriculum went through many editions and is now widely accepted by the provincial Department of Education. As a result, the Quang Binh and Quang Tri provinces' local Departments of Education and Training have integrated the CRS MRE materials into 20 percent of their overall curriculum, which is determined by the local culture, geography and students' primary needs. The other 80 percent of the curriculum in the provinces is considered the compulsory national curriculum, which the national government determines.

#### Effectiveness of the CRS MRE Resources

In previous CRS project communities, no child who received MRE was killed or injured by incidents involving landmines/UXO, and adult casualty rates dropped by as much as

50 percent. Previous project communities include the Trieu Phong and Gio Linh districts of Quang Tri province and the Tuyen Hoa and Minh Hoa districts of Quang Binh province.

Clear Path International provided reports on landmine/UXO casualty rates, which indicated that the trend in UXO incidents decreased from 2005 through the first five months of 2011.[2] The rate of accidents in primary school-aged children reduced dramatically. Throughout the five-year period, 14–18 year olds represented a significant percentage of casualties for those under age 18. In Quang Tri province, eight children in this age group were injured or killed, accounting for roughly 23 percent of the casualties in Vietnam during 2005.[2,3] Since then, child casualties decreased—only four children were killed or injured in 2009. From 3 December 2012 to 2 January 2013, however, 12 children were killed/injured (five dead/seven injured) due to old mortars and bombs, indicating that landmines, UXO and ERW still heavily impact Vietnam.[4]

The CRS approach of targeting specific at-risk groups proved effective in reaching all sectors of the community, as demonstrated through increased knowledge, awareness and behavior regarding MRE among students and community members. In the PM/WRA 2010–2011 grant, a 10 percent sample of students who participated in the project were selected for testing prior to and after implementation of the MRE training.[5,6] The comparative results of pre- and post-tests indicate that the in-school training increased the level of UXO understanding and accident prevention among students. The most recent progress report in May 2011 showed that, as a result of the CRS in-school MRE training, the percentage of students aware of what landmines/UXO look like, how accidents happen, how to avoid these incidents and the effects incidents have on victims and their families increased significantly, from 24 to 62 percent, in the Le Thuy district of Quang Binh province.

*See endnotes page 66*

**Ta Thi Hai Yen** is the Project Coordinator for Catholic Relief Services Vietnam. She has worked for the Mine Risk Education project for CRS since 2007. She is also a graduate of the Center for International Stabilization and Recovery's Senior Managers' Course in ERW and Mine Action at James Madison University.

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# News Brief

## Geneva Call Launches First ANSA Database

GENEVA CALL
Appel de Genève
Llamamiento de Ginebra

In November 2012 Geneva Call launched "Their Words," an information database. The database provides published commitments and internal rules and regulations of armed non-state actors. Issues such as the protection of children and civilian populations, the use of anti-personnel mines and compliance with the Geneva Convention are made public and accessible.

The publication of commitments and rules written by and for ANSAs is intended to encourage other non-state actors to enact and follow regulations that ensure the protection of civilian populations. The database provides examples in various contexts of how these codes can be created and implemented. For example, the Syrian rebellion seeks to create a code of conduct for its current efforts. The database provides the means for the Syrian rebels to research codes of conduct and take examples from other ANSAs.

The database is organized by topic/theme and geographic location of ANSAs. To access the database, use the following link: http://theirwords.org/pages/home.

~ Paige Ober, CISR staff

25 August 2021

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

Sincerely,
The Journal of CWD

OBITUARY

# *In Remembrance:* Lawal Johnson

With great sadness, Novetta Solutions announces the unexpected death of Lawal Johnson, who died 2 January 2013. As a software developer and technical program manager working on the Information Management System for Mine Action program on behalf of the Geneva International Centre for Humanitarian Demining, Johnson played an essential role in the development and fielding of IMSMA. She began working in mine action in 2002, first as a software developer and later as the technical program manager responsible for leading the IMSMA development team.

Johnson touched the lives of many in the mine action community through her work providing advanced IMSMA field support and data migration to IMSMA users. Many may not have noticed her behind-the-scenes influence as a tireless and devoted advocate for IMSMA users, but Johnson's far-reaching impact on the information-management community affected a large number of mine action programs over the years.

Johnson is survived by her husband, Tim, and son, Andrew. The mine action community, GICHD and the Novetta Solutions-FGM family will miss her friendship, passion, commitment and dedicated service. "Lawal's exceptional skills as a software developer and project manager coupled with her devotion to the mine action cause were key to the success of IMSMA NG," says Daniel Eriksson, GICHD head of management consulting. "She will be missed as a friend and colleague by all of us in the information-management team at GICHD."

*~ Contributed by Noah Klemm, GICHD.*

# RESEARCH & DEVELOPMENT

Research and Development Section Sponsored by

# Influence of Soil Properties on the Performance of Metal Detectors and GPR

This article examines the effects of four soil types on metal detector and GPR performance and proposes the development of a classification system based on soil type to aid in the selection of effective methods for manual demining.

by Kazunori Takahashi [ Graduate School of Science, Tohoku University ], Holger Preetz [ Federal Competence Center for Soil and Groundwater Protection / UXO Clearance ] and Jan Igel [ Leibniz Institute for Applied Geophysics ]

Although landmine clearance employs various techniques, manual demining still accounts for a large part of mine-removal operations. The metal detector is the most common tool used in manual demining. Ground-penetrating radar was studied and tested as a complementary tool to the metal detector, because it can identify buried objects and accelerate operations. As the metal detector and GPR employ electromagnetic techniques, the soil's magnetic, electric and dielectric properties influence both devices. If the influence is significant, these tools may not provide reliable information and the safety of operations cannot be assured. Studying how soils affect detection and how the detectability of the mines is influenced is important. In this article, field experiment results illustrate soil influence on detection performance.

| | Laterite | Magnetic Sand | Humus A | Humus B |
|---|---|---|---|---|
| **Humus [% of total soil]** | 0.8 | <0.5 | 2.7 | 12.4 |
| **Clay [% of mineral soil]** | 31.5 | 1.3 | 16.6 | 17.1 |
| **Silt [% of mineral soil]** | 39.4 | 7.0 | 48.4 | 40.7 |
| **Sand [% of mineral soil]** | 29.1 | 91.7 | 35.0 | 42.2 |

Table 1. Texture and humus content of the test soils.
*All graphics courtesy of the authors.*

## Influential Soil Properties on Sensors

**Magnetic susceptibility** is the most influential soil property affecting metal detectors.[1] In general, the value of magnetic susceptibility at a certain frequency affects continuous wave metal detectors, and frequency dependence has more influence on pulse-induction detectors.[2] Soil with a high susceptibility or frequency dependence generates additional responses to metal detectors. These responses can be misinterpreted as metal detection and/or interfere with responses from landmines so that the signature of the mine is changed. This can result in false alarms or missed mines. Although magnetic susceptibility theoretically affects GPR, it must be extremely high to influence the signal. For example, reportedly, susceptibility must be greater than 30,000 x 10-5 SI to be influential compared to dielectric permittivity.[3] Values in this range are exceptional even for tropical soils, which are often highly susceptible, making the influence of magnetic susceptibility on GPR practically negligible.[4]

Electromagnetic induction-based devices can easily measure magnetic susceptibility at a single frequency. The measurements at multiple frequencies may require soil sampling and laboratory setups.

If the electric conductivity of soil is extremely high, then it also influences metal detectors, though to a lesser extent than magnetic susceptibility.[1] In contrast, the normal range of conductivity influences GPR. This property relates primarily to the attenuation of electromagnetic waves; a radar signal cannot propagate a long distance in a highly conductive medium. Anti-personnel mines are often shallower than 20 cm; thus the soil influence on radar signals may not be so critical. For example, electric conductivity of 60 mS/m, which is very high for normal soils unless they contain salt or clay, attenuates radar signals to $1/e$ (~-8.7 dB) at a 20-cm depth in relatively wet soil (volumetric water content of 35%).

**Dielectric permittivity** also greatly influences GPR, and it directly relates to water content in the soil.[5,6] In most soils, the permittivity contrast between two materials mainly defines the reflectivity of radar signals. The difference in permittivity between soil and a buried object generates reflected signals, which are interpreted to identify a target. However, a permittivity change within the soil also generates reflected GPR signals, and they can be misinterpreted as an object. Additionally, a change may confuse signals reflected from a target. Therefore, dielectric permittivity is the most influential soil property on GPR performance.

A time-domain reflectometry probe can easily measure permittivity at a single location in the field. The spatial distribution can be obtained by repeating TDR measurements at various locations. A reliable determination of frequency dependence requires soil sampling and laboratory measurements.

## Testing Metal Detectors and GPR

The International Test and Evaluation Program for Humanitarian Demining tested metal detectors and a dual sensor in Germany in 2009 to evaluate their field performance. Kazunori Takahashi and Dieter Gülle reported details of the test conditions and general considerations.[7,8] This test used the following four soil types:

- Laterite: an iron-rich tropical weathered soil, a red-colored clay loam with stone content of approximately 2–5%.[9]
- Magnetic sand: an artificial mixture of coarse sand and engineered magnetite with low fine-gravel content (2–5%).

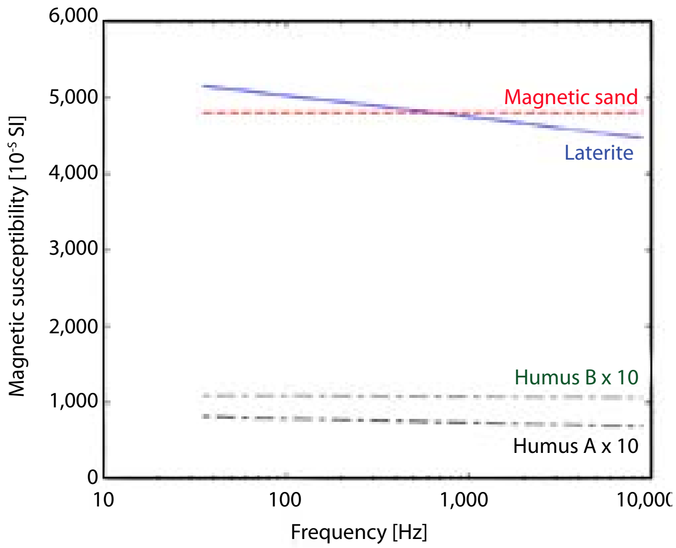


Figure 1. Frequency dependence of magnetic susceptibility of the test soils. Note that the magnetic susceptibility of humus A and B was multiplied by a factor of 10 for visibility.

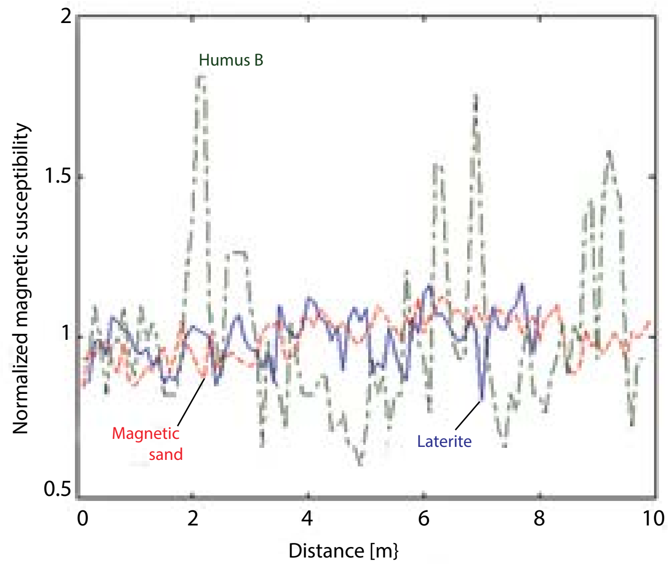


Figure 2. Spatial distribution of magnetic susceptibility for the test soils measured in 10-m long profiles at a frequency of 958 Hz. Values in this figure were normalized by the mean.

- Humus A: a humus loam originated from loess.[10,11]
- Humus B: a loamy humus forest soil with high stone content (about 30–40%) and high humus content.

Table 1 (page 52) summarizes the texture and humus content of the test soils. In these soils, blind tests of various detector models were used to calculate the following performance measures:

- Probability of detection: the number of targets detected relative to the total number of targets
- False alarm rate: the number of false alarms produced
- False alarm rate reduction: the number of metal junk the GPR correctly identified
- Probability of detection loss: the number of mines the GPR falsely identified as metal junk [7,8]

## Analyzing Soil Properties

A susceptibility bridge (Magnon VFSM) measured the frequency dependence of magnetic susceptibility on soil samples at the laboratory. Figure 1 (page 53) shows the results. Both laterite and magnetic sand showed very high magnetic-susceptibility values; however, only laterite exhibited significant frequency dependence. Humus A and B had much lower values, but only humus A demonstrated a relatively high frequency dependence. Figure 2 (page 53) shows the spatial variation of the normalized magnetic susceptibility in a 1-D profile measured at a frequency of 958 MHz in the field using a susceptibility meter (Bartington MS2 and its field loop MS2D). Only humus B exhibited remarkable spatial variation; however, the absolute level in humus B was very low (Figure 1 on page 53), and the absolute variation was thus small. Based on this result and classification systems of soil influence dependent on magnetic susceptibility, laterite is expected to significantly influence metal detectors because of the very high susceptibility values and frequency dependence of magnetic susceptibility.[12,13] In contrast, the easiest soil for metal detectors was humus B. All soils showed magnetic susceptibility much lower than 30,000 x $10^{-5}$ SI, and no significant influence on GPR was expected in any type of soil.

The spectral-induced polarization method (Radic-Research SIP Fuchs Lab) measured the frequency dependence of electric conductivity in the laboratory, and 3-D resistivity imaging (DMT Resecs) obtained the spatial distribution in the field. Figures 3 (page 53) and 4 (page 54)

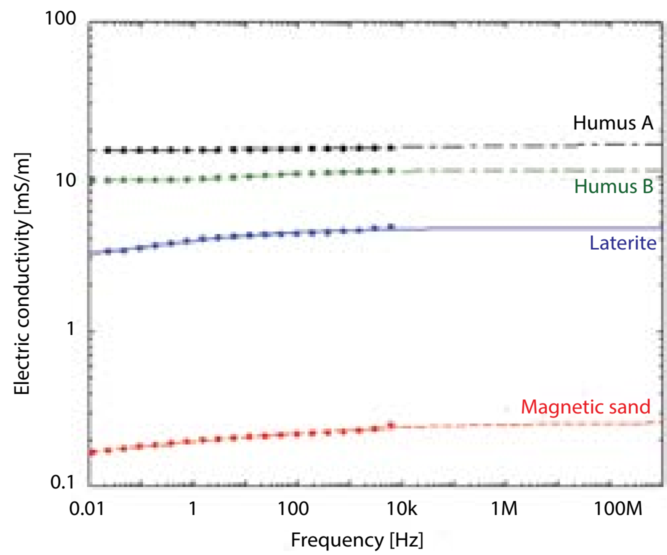


Figure 3. Frequency dependence of electric conductivity of the test soils. The dots and lines show the measured values and model fits, respectively.

show the results. Conductivities in all soils were in the normal range and not particularly high. For example, a depth that attenuates radar signal to 1/*e* is more than 1 m in humus B, which exhibits the highest conductivity among all. Some amount of spatial variation can be observed in Figure 4, but again, the level is not high. Therefore, the influence of electric conductivity on metal detectors and GPR was expected to be negligible in these soils.

Spatial changes in dielectric permittivity were measured in the field every 10 cm along 10 m profiles with a time-domain reflectometry (FOM/mts, Institute of Agrophysics of the Polish Academy of Sciences), as Figure 5 (page 55) indicates. Magnetic sand showed a low and constant permittivity. Mainly because of the very small variation, clear radar signatures of targets were expected in magnetic sand. However, laterite and humus showed higher permittivity (higher water content) and larger spatial variations. The spatial variation causes additional response to GPR, which disturbs the signatures of targets. Therefore,

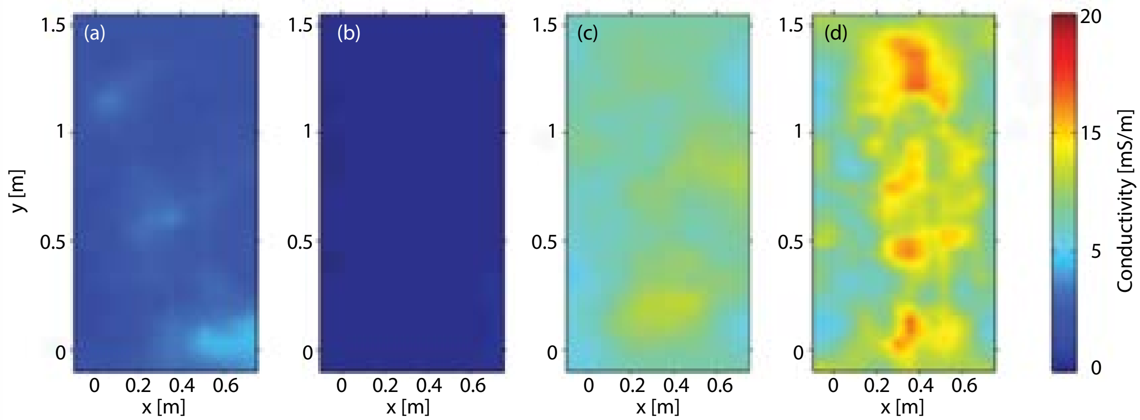

Figure 4. Spatial distributions of electric conductivity at a depth of 5-10 cm in (a) laterite, (b) magnetic sand, (c) humus A, (d) humus B.

| | Laterite | Magnetic Sand | Humus A | Humus B |
|---|---|---|---|---|
| **κ at a certain frequency** | Very high | Very high | Very low | Very low |
| **Frequency dependence of κ** | Very high | Low | High | Low |
| **Spatial variation of κ** | Small | Small | N/A | Very large |
| **σ at a certain frequency** | Low | Very low | Low | Low |
| **Spatial variation of σ** | Large | Very small | Small | Large |
| **Absolute level of $\epsilon_r$** | High | Low | High | High |
| **Spatial variation of $\epsilon_r$** | Large | Very small | N/A | Very large |
| **$\epsilon_r$ at a certain frequency** | Very severe | Moderate | Moderate | Neutral |
| **Impact on GPR** | Moderate | Neutral | Moderate/severe | Very severe |

Table 2. Qualitative evaluation of measured soil properties and comprehensive estimation of soil impact on the performance of detectors. κ, σ and ϵ denote magnetic susceptibility, electric conductivity and dielectric permittivity, respectively.

laterite and humus may be problematic for GPR. Especially in humus, the correlation length, which describes dimension of the variation cycle in space and was determined by further analysis, was similar to the target dimension. Therefore, humus was expected to more severely impact GPR than laterite.

Table 2 (page 54) summarizes the qualitative evaluation of soil-property measurements and provides a comprehensive estimation of soil impact on metal detectors and GPR.

## Soil Properties and Detector Performance

The performance of metal detectors (probability of detection and false alarm rate) calculated from the test results is shown in Figures 6 and 7 (page 55) with respect to soil difficulty shown in Table 2 (page 54). In Figure 6 (page 55) the performance measures are the average of all metal detector models tested. This figure clearly exhibits that POD (positive feature) decreased and FAR (negative feature) increased as soil became more difficult. In Figure 7 (page 55) the averaged performance measures of metal detectors are plotted for pulse-induction detectors and continuous wave detectors separately. A significant difference between PI and CW detectors is observed in FARs in magnetic sand. The FAR of a PI detector is lower than the FAR of a CW detector in magnetic sand, which showed a high magnetic susceptibility but no frequency dependence. This result confirms that the susceptibility value at a certain frequency influences CW metal detectors more than PI detectors.[2]

Figure 8 (page 55) shows the identification performance of GPR (FAR reduction and POD loss) with respect to soil difficulty. Note that the order of soil types in the horizontal axis according to the estimated soil impact is different for GPR (Figure 8, page 55) and metal detectors (Figures 6 and 7, page 55), since the test-soil difficulties were graded differently for each. In the case of GPR performance, FAR reduction (positive feature) was nearly constant for all test soils, and POD loss (negative feature) increased with soil difficulty. Therefore, GPR performed poorly in soils classified as difficult. These results demonstrate that comprehensive soil characterization and classification, according to the geophysical analyses, agreed with the performance of detectors.

## Discussions

Soil characterization, based on geophysical measurements, agreed with detector test results: high POD and low FAR in unproblematic soil, and low POD and high FAR in difficult soil for metal detectors; low POD loss in easy soil, high POD loss in difficult soil and constant FAR for GPR. The results indicate that the performance of detectors can be predicted qualitatively by analyzing soil properties obtained by geophysical measurements.

As shown, heterogeneity and spatial distribution of soil properties are necessary to assess detector performance, especially for GPR. The soil characterization for sensors shown in this article is very general, and the criteria for grading soils can be applied to all detector models. However, because each metal detector and dual-sensor model is unique, the amount of soil influence on performance (i.e., the slopes of curves in Figures 6–8, page 55) ) may differ.

Detector performance can be assessed during clearance through soil characterization as follows: Geophysical measurements can be carried out on a representative area, other than the minefield, before actual

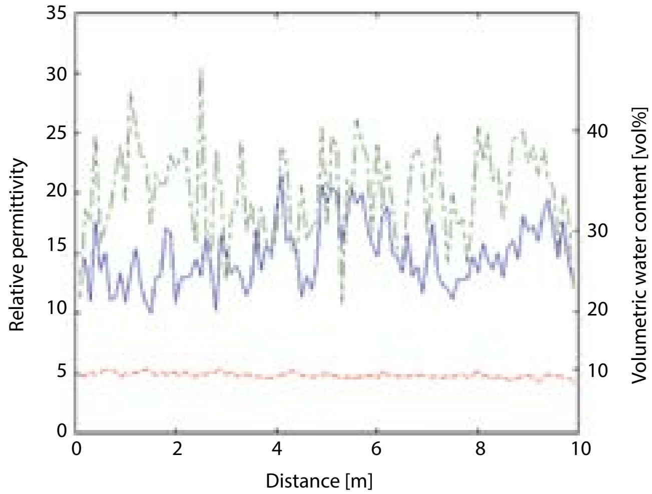


Figure 5. Spatial distribution of relative permittivity of the test soils measured in 10-m long profiles and corresponding water content determined by an empirical equation.[11]

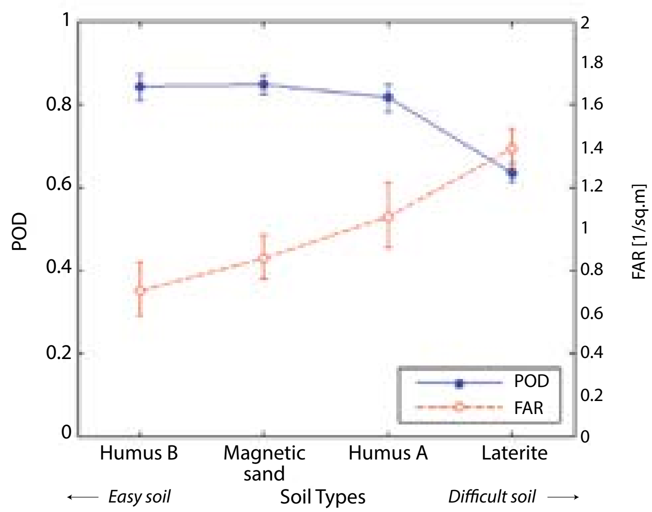


Figure 6. Performance of metal detectors in terms of POD (blue dots with solid line) and FAR (red circles and dashed line) averaged over all models tested. Soil on the left side is considered to be easy and soil on the right side is considered to be difficult. The error bars show 95% confidence bounds.

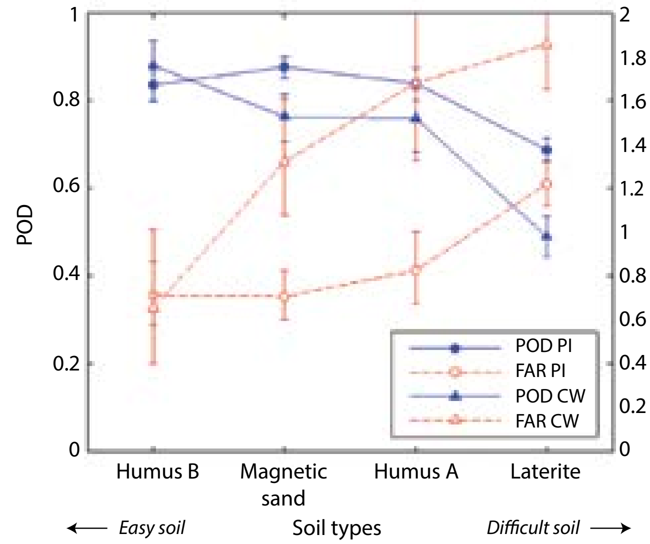


Figure 7. Performance of metal detectors in terms of POD (blue solid lines) and FAR (red dashed lines), separately calculated for pulse induction (PI, plotted with circles) and continuous wave (CW, plotted with triangles) detectors. Soil on the left side is considered to be easy and soil on the right side is considered to be difficult. The error bars show 95% confidence bounds.

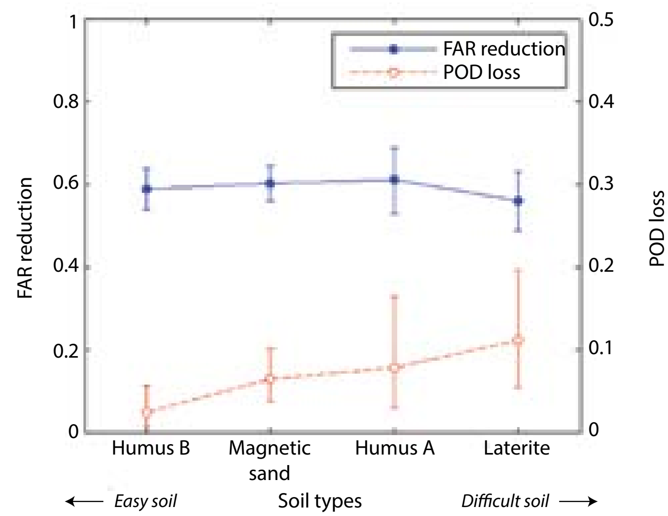


Figure 8. Performance of GPR in terms of FAR reduction (blue dots with solid line) and POD loss (red circles and dashed line). Soil on the left side is considered to be easy and soil on the right side is considered to be difficult. The error bars show 95% confidence bounds.

demining operations, i.e., in the stage of Technical Survey. The soil characterization allows for the selection of appropriate clearance techniques. For example, if soils in an area are assessed as easy for GPR, the use of a dual sensor in this area may accelerate clearance operations. However, if soils are assessed as difficult for GPR, a dual sensor should not be used because the operations may not be safe and/or effective. Furthermore, if soils are expected to be difficult for metal detectors, manual prodding should be used. Such performance assessment and selection of detection techniques can reasonably be made by analyzing soil properties. As a complementary survey, geophysical measurements are very useful for mine clearance with detectors.

Only four soil types were available for this study, although these soils were selected to represent a wide variety of natural soil types in mine-affected countries. By collecting more samples, a classification system based on soil magnetic and dielectric properties may be established. Such a classification system will advance the benefit and safety of using metal detectors and GPR for clearance.

Detailed results of geophysical measurements shown in this article can be found in Preetz et al., and a more technical, detailed discussion of the analysis can be found in Takahashi et al.[15,16,17,18]

*See endnotes page 66*

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# News Brief

## Poland Ratifies the APMBC

On 4 December 2012 Poland became the 161st state to ratify the 1997 *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction* (Anti-personnel Mine Ban Convention or APMBC).[1] Poland originally signed the APMBC in 1997.[1] The Undersecretary of State at the Ministry of Foreign Affairs, Maciej Szpunar, made the announcement at the 12th Meeting of the States Parties to the APMBC, which took place in Geneva, Switzerland, on 3–7 December 2012.[2]

Explosive remnants of war and a small number of landmines from World War II and the Soviet occupation heavily contaminated Poland. However, the Polish Ministry of Defense states that mined areas or areas suspected of mine contamination no longer remain, eliminating the need for regular clearance or mine risk education programs.[3] Nonetheless, Polish armed forces conduct landmine and ERW clearance in response to emergency requests for explosive ordnance disposal and in routine checks on former Soviet and Polish military bases before they are handed over to local civilian communities.[4]

The APMBC will take effect in Poland on 1 June 2013. Remigiusz Henczel, Poland's ambassador to the U.N. in Geneva stressed Poland's commitment to a world without landmines, stating that Poland is "ready to actively participate in endeavors promoting the universal adherence to the Convention and its humanitarian impact."[1]

*See endnotes page 67*

~ Sarah Peachey, CISR staff

# Detecting and Classifying UXO

This article presents state-of-the-art unexploded ordnance detection and classification, including examples from recent field-demonstration studies. After reviewing sensor technologies, with a focus on magnetic and electromagnetic systems, the authors discuss advanced processing techniques that allow for reliable discrimination between hazardous ordnance and harmless metallic clutter. Finally, the article shows results from a large-scale field demonstration conducted in 2011. In this case study, electromagnetic data acquired with an advanced sensor is used to identify ordnance at the site, reducing the number of excavations required with conventional metal detectors by 85%.

by Laurens Beran [ Black Tusk Geophysics Inc. and the University of British Columbia ], Barry Zelt and Stephen Billings [ Black Tusk Geophysics Inc.]

The extent of global unexploded ordnance contamination has motivated research into improved technologies for unexploded ordnance detection and classification. In particular, the U.S. Department of Defense's Environmental Science Technology Certification Program has funded the development of sensors and data-processing techniques specially designed to reliably identify buried UXO.

As part of this research effort, ESTCP conducted a series of field demonstrations to validate detection and classification technologies. The first demonstration, conducted in 2010 at Camp Sibert, Alabama (U.S.), required the discrimination of large 4.2-in mortars from metallic ordnance debris.[1] Subsequent demonstrations progressively increased in difficulty. For example, the 2011 Camp Beale demonstration (Marysville, California, U.S.) required the identification of small 37-mm projectiles and fuzes in rigorous terrain. Throughout the demonstration program, a number of participants achieved near-perfect UXO identification.[1,2,3,4]

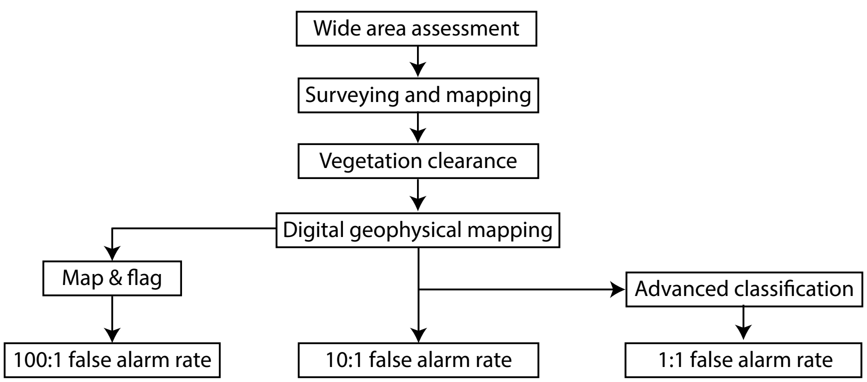



Figure 1. Flowchart for remediation of UXO. Wide area assessment identifies areas of likely UXO contamination at a site, followed by detailed mapping to delineate survey areas. Vegetation must also be cleared to allow deployment of sensors for detection of buried metal. Projected false-alarm rates for remediation strategies (mag and flag, digital geophysical mapping and advanced classification) are for typical munitions response sites within the United States. *All graphics courtesy of the authors.*

## Detection

Figure 1 depicts paradigms for detection and classification of buried UXO. The conventional **mag-and-flag** approach uses metal detectors operated by expert technicians to identify targets, which are then flagged for subsequent digging. No digital data are recorded, and changes in an audio tone usually indicate detection. This method is not consistent because success depends upon the operator's skill. In addition, the mag-and-flag approach offers limited possibility for discrimination between hazardous ordnance and clutter. Although the projected cost of this approach is prohibitively high (Figure 1), the mag-and-flag approach will always have a role in UXO clearance—primarily to survey areas inaccessible to other sensors (e.g., around trees, in gullies) and as a first stage clearance of highly cluttered areas.

The second mode of UXO detection, **digital geophysical mapping**, uses geophysical sensors connected to a data-acquisition system to record digitized data acquired over a survey grid. DGM data are subsequently processed to identify high priority targets, which are likely to be buried ordnance. Simple processing techniques, such as digging detected targets based on the measured data's amplitude, can reduce the number of false responses to approximately 10 non-UXO per UXO excavated. Applying advanced classification methods to digital geophysical data further reduces the rate of these false responses and greatly increases confidence of successful ordnance clearance. In a technical report published by the U.S. Office of the Undersecretary of Defense for Acquisition, Technology and Logistics, Delaney and Etter estimate the cost of UXO remediation projects within the U.S. at US$52 billion with mag and flag, versus $16 billion with advanced classification.[5]

Magnetic and electromagnetic geophysical data types are most commonly acquired for UXO detection and discrimination. Magnetic instruments are used to measure distortions in the Earth's geomagnetic fields produced by magnetically susceptible materials (e.g., steel). Magnetic sensors deployed for UXO detection typically either measure the total magnetic field (scalar measurement) or the difference between two closely spaced magnetometers, measuring

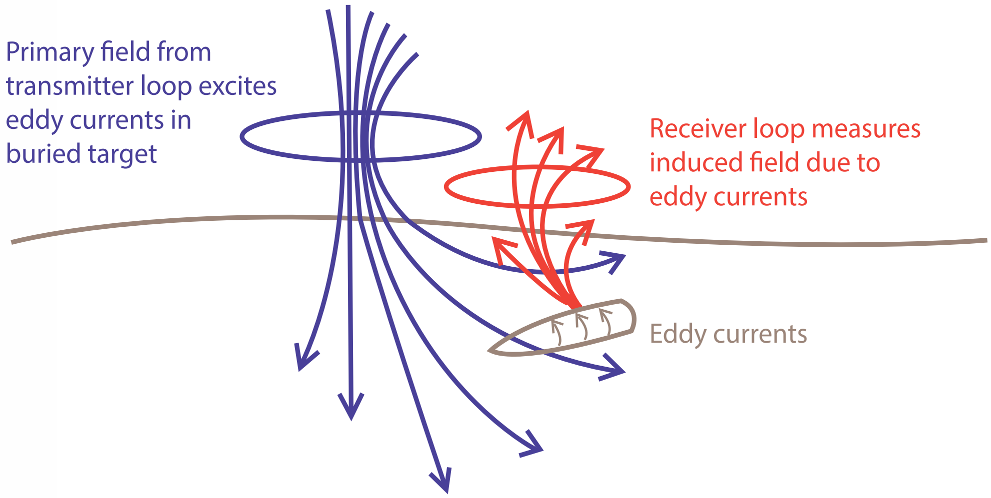



Figure 2. Electromagnetic induction survey. Eddy currents are induced in a buried target by a time-varying primary field. Decaying secondary fields radiated by the target are then measured by a receiver at the surface.

the vertical component of the magnetic field (gradiometer measurement). Magnetic-sensor arrays have been deployed for helicopter-borne surveys (**heli-mag**) in wide-area assessments.[6] Multiple magnetometers can also be arranged in arrays for ground-based surveying, using wider swaths to decrease the number of passes required to cover a given area. A significant background soil response, which can obscure identification of discrete targets in the measured signal, often complicates the processing of magnetic data. In addition, magnetic data can only provide limited information about intrinsic target properties (i.e., size and shape) and are rarely used to classify detected targets as UXO and non-UXO.[7] Therefore, the remainder of this article focuses on classification with electromagnetic data.

Processing of electromagnetic data produces a unique intrinsic response (or fingerprint) for each target, which can then be matched with responses for known ordnance types. As depicted in Figure 2, electromagnetic instruments actively transmit a time-varying, primary magnetic field that illuminates the Earth. The variation of the primary field induces currents in the ground, and these currents produce a secondary field that a receiver on the surface can measure. EM sensors measure the decay of these secondary fields after the primary field is switched off. The secondary fields, in turn, provide information regarding electrically conductive items in the ground.

EM sensors designed for UXO applications come in a wide variety of geometries, ranging from cart systems with multiple transmitters and receivers to single loop, man-portable systems. The Geonics EM-61, an ubiquitous time-domain instrument, transmits from a single horizontal coil. When the primary field is terminated, the EM-61 measures the decaying secondary field in a horizontal receiver loop at four discrete time channels. This instrument is robust, easy to use and consequently, popular for UXO detection and other environmental applications. However, the range of time channels is fairly short, and the paucity of receiver and transmitter combinations (relative to newer systems) limits this instrument's classification capability.

Table 1 shows EM sensors, which have been applied to UXO detection and classification problems. This is not a comprehensive list of EM sensors, but is intended to illustrate the recent evolution of sensors from few channels to many channels over a long period of time and the shift toward configurations with multiple transmitters and receivers.

Two types of surveys, or search patterns, are common with EM instruments.[6] A detection-mode survey passes the sensor over an area along closely spaced parallel lines, typically such that adjacent sensor passes are between 50 and 100 cm apart. Sometimes perpendicular lines are also acquired to maximize data coverage over targets and ensure their illumination from multiple angles. The data are acquired approximately every 10 cm along each line. Towed arrays of EM sensors can quickly cover large areas, while single-sensor pushcart systems are much slower. Pushcart or man-portable EM systems are therefore better suited to the cued-interrogation mode of surveying. In this mode, a DGM survey initially identifies anomalies, and high fidelity data are subsequently acquired over each target. Recently developed systems for stationary cued interrogation (e.g., MetalMapper and TEMTADS, Table 1) illuminate the target with multiple transmitters and receivers, thereby circumventing the requirement for accurate positioning of moving sensors.

## Classification

Once a digital geophysical map with a ground-based sensor is acquired, a number of processing steps are required to produce a prioritized dig list of targets for excavation. Figure 3 shows the typical processing involved in advanced classification.

Target selection identifies anomalies in the digital geophysical map down to a pre-defined amplitude threshold. The threshold is usually based upon the minimum expected data amplitude for the smallest target of interest (i.e., UXO) at a site. All designated targets are then revisited to acquire cued-interrogation data from each one.

Each designated anomaly is characterized by estimating features from the cued data, which subsequently allows a data analyst to discern UXO from nonhazardous clutter. These features may directly relate to the observed data (e.g., anomaly amplitude at the first time channel), or they may be the parameters of a physical model. The former approach is appealing in its simplicity but is generally not an effective strategy for classification. An ordnance item at depth will produce a small anomaly amplitude and might be left in the ground with a dig list based solely upon anomaly amplitude. Most classification strategies therefore use physical modeling to resolve such ambiguities.

Bell et al., Pasion and Oldenburg, and Zhang et al. give detailed descriptions of the physical modeling used for processing EM data.[8,9,10] In the feature estimation stage, these models are fit to the observed EM data for each target anomaly. This fitting is analogous to fitting a straight line to data via least-squares regression. In that case the model is parameterized by slope and intercept; here the model is parameterized by target location,

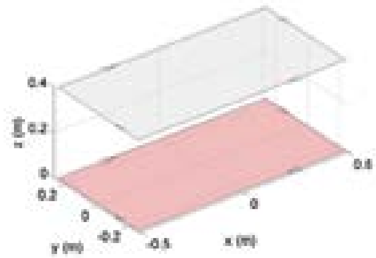
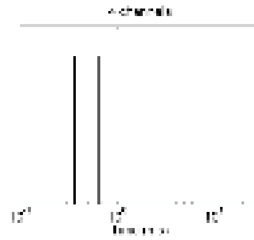
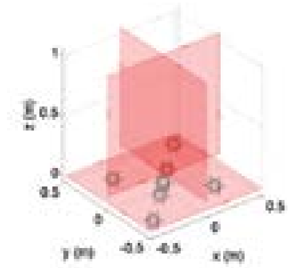
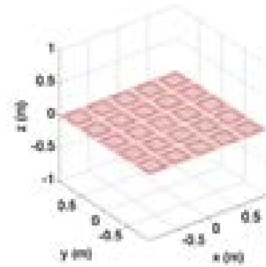
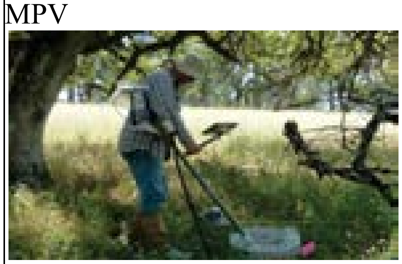
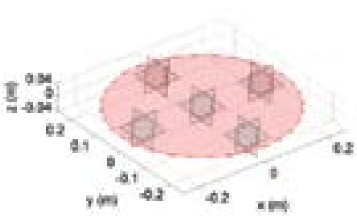
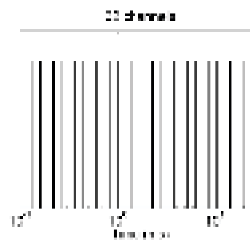
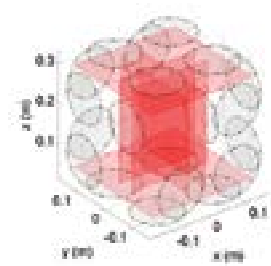
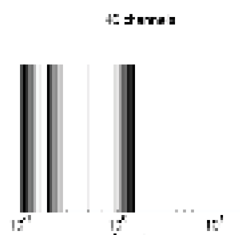
| Sensor | Geometry | Time channels |
|---|---|---|
| EM-61  |  |  |
| MetalMapper  |  |  |
| TEMTADS  |  |  |
| MPV  |  |  |
| BUD  |  |  |

Table 1. Electromagnetic sensors used for UXO detection and classification. Red and black lines in the middle column indicate transmitters and receivers, respectively.

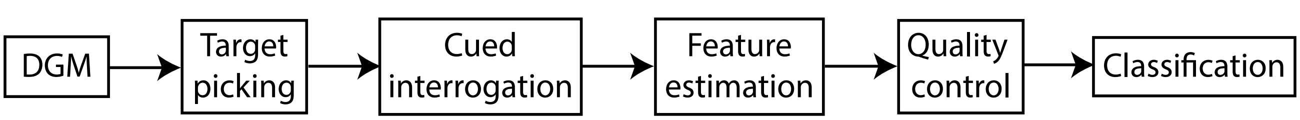



Figure 3. Processing steps for UXO classification.

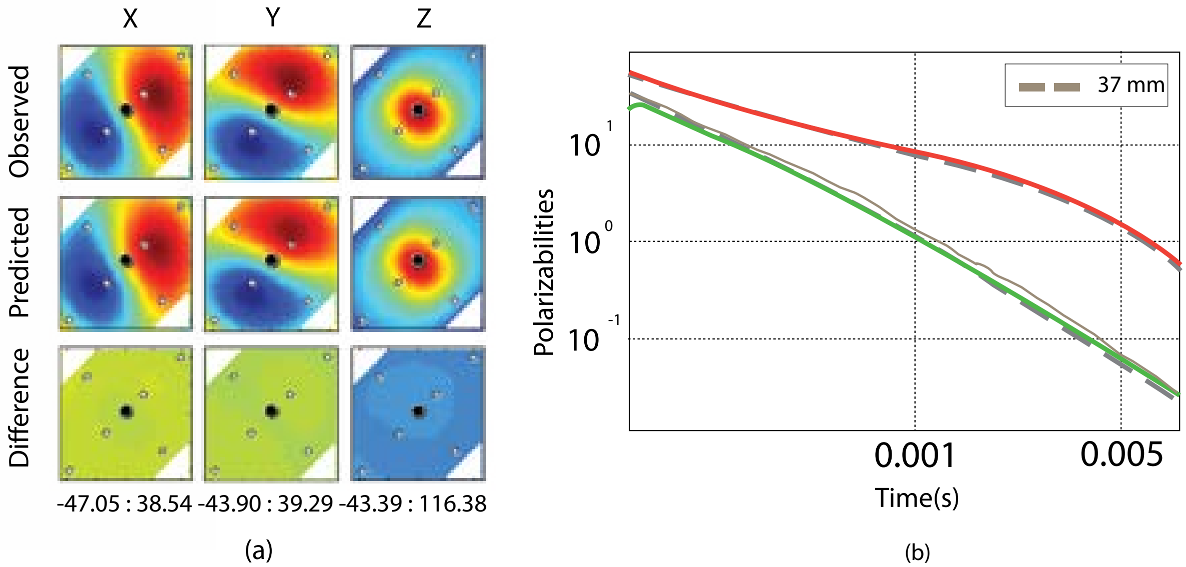



Figure 4. Fitting MetalMapper data. (a) Observed data (top row) and data predicted by fitting a physical model to the observed data (middle row). Bottom row shows the (negligible) difference between observed and predicted data. Each column shows the X, Y and Z components of the measured data, with MetalMapper receiver locations indicated by white circles. The black circle is the estimated location of the target. Numbers at the bottom of each column indicate the range of data values (in arbitrary units). Colored images map blue and red to low and high data values, respectively. (b) Estimated polarizabilities (colored lines) recovered via fitting, overlain on known polarizabilities for 37-mm projectiles. The excellent correspondence between recovered and reference polarizabilities indicates—with high confidence—that the detected target is a 37-mm item.

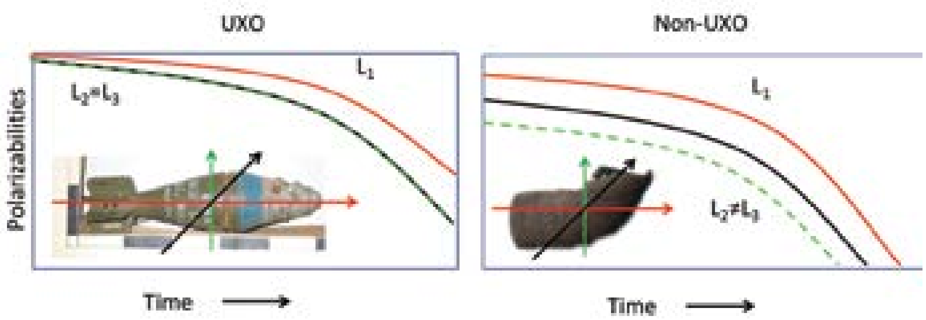



Figure 5. Comparison of representative polarizabilities for UXO and non-UXO items.

orientation and polarizabilities. The polarizabilities are intrinsic to each target and hence classification decisions can be made based on the match of the estimated values to those of known UXO types. Figure 4 shows an example of this fitting procedure and the recovered polarizabilities for MetalMapper data acquired over a 37-mm projectile.

Figure 5 compares typical polarizabilities for UXO and non-UXO items. The primary polarizability (L1) aligns with the long axis of the target. UXO generally have larger amplitude, slower decaying polarizabilities relative to small clutter. Shape information is encoded in secondary polarizabilities (L2 and L3). Most UXO have a circular cross section and will have L2 ≈ L3. In contrast, for irregularly shaped clutter, these parameters differ significantly. These differences in polarizabilities allow for distinction between buried UXO and clutter.

An important step in UXO data processing is visual quality control of the fit to each target. The example in Figure 4 represents the ideal case: a near-perfect fit to the data and an excellent correspondence between the estimated polarizabilities and expected values for the target's class. However, feature estimation is often complicated by neighboring target anomalies or low signal strength from small or deep (> 30-cm) targets. In these particular situations, noise will affect the fitting to the observed data, and may produce unreliable polarizabilities. An additional complication sometimes encountered in data processing can be a strong background soil response superimposed on the target response. Soil compensation algorithms can be applied to the EM data to remove these effects and recover reliable polarizability estimates.[11]

Careful inspection of all fits by expert data analysts is essential to ensure that the field data for each target anomaly can support classification decisions. When data quality is poor for individual targets, the data may be reacquired or, in the worst case, the target must be dug as a precaution. With newer sensor data and careful field practices, the number of anomalies that cannot be analyzed is usually negligible (less than 1% of the total).

## Case Study: Pole Mountain

MetalMapper data were collected for an ESTCP demonstration of classification technologies at Pole Mountain, Wyoming (U.S.), in July 2011. The conditions at this site were relatively benign: Soil response was minimal, and little topography or vegetation impeded data collection. A total of 2,370 items were excavated at Pole Mountain, with 160 of these items identified as UXO. The UXO fell into six classes: Stokes mortars, 60-mm mortars, 75-mm, 57-mm and 37-mm projectiles, and small industry-standard objects (see representative photos in Figure 5). While ESTCP dug all targets, the identities of the objects were unknown to the analysts who needed to develop a classification strategy

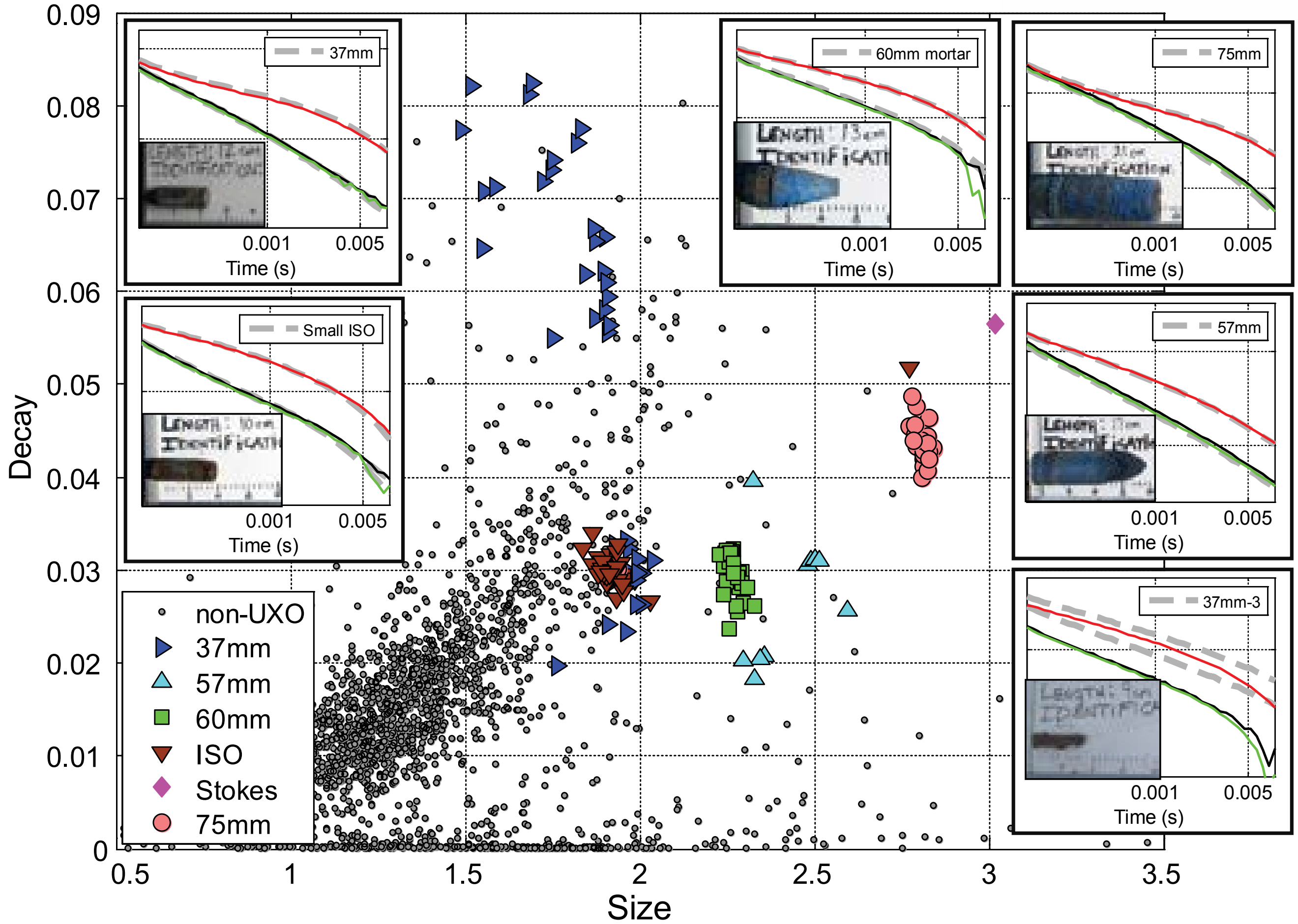



Figure 6. Decay versus size features space for Pole Mountain. Each point represents an individual target, with markers colored based on the similarity of the estimated polarizabilities to known UXO. Insets show estimated polarizabilities for selected targets, with heavy dashed lines indicating the expected reference polarizabilities for that item's class.

and decide which items were potentially hazardous UXO and which were harmless shrapnel or range debris.

Figure 6 shows a plot of size and decay parameters for all Pole Mountain targets. These parameters are computed from each target's estimated polarizabilities and provide a convenient way of visualizing the variability of target properties across the site. UXO are roughly characterized by large amplitude, slow-decaying polarizabilities and cluster in the upper right portion of Figure 6. Clutter items are generally smaller, fast-decaying and cluster near the origin. The degree of overlap between these two clusters dictates the difficulty of the classification task. The Pole Mountain data represents an easy classification task where UXO and non-UXO polarizabilities are readily distinguished. This is illustrated for selected items in Figure 6.

The end product of classification processing is an ordered list of targets prioritized by how well they match the polarizabilities of known UXO. The data analyst also specifies a **stop dig** point in this dig list at which all remaining targets are deemed nonhazardous clutter and can be safely left in the ground. Selecting the stop dig point is crucial to the success of remediation efforts at a site: The analyst must ensure all UXO are found while minimizing the number of unnecessary digs.

At Pole Mountain, a stop dig point that found all 160 UXO was easily chosen, resulting in only 153 non-UXO digs. Figure 7 shows the resulting reduction in digs relative to conventional data processing with the EM-61 instrument. These dramatic savings are typical of results obtained with next-generation sensors such as the MetalMapper, coupled with advanced classification techniques.

## Conclusions

Sensor and data processing technologies developed under the ESTCP program have repeatedly achieved excellent classification performance in blind field demonstrations. Results depend on the difficulty of the classification task and the quality of the field data. However, improvements in field procedures, including real-time processing of acquired data, are expected to make results similar to those attained at Pole Mountain more routine.

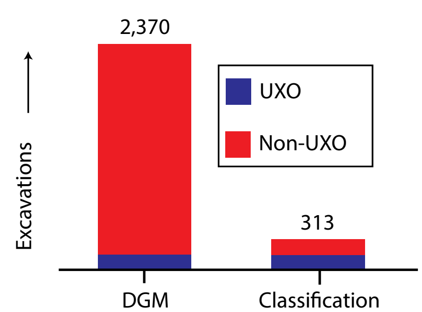



Figure 7. Comparison in total number of targets excavated in order to find all (160) UXO at Pole Mountain, for conventional data processing of a digital geophysical map acquired with the EM-61 and advanced classification with the Metal Mapper.

The current ESTCP development emphasis is based on testing smaller, man-portable systems such as the Handheld Berkeley UXO Discriminator (BUDHH) and the Man-Portable Vector Sensor (Table 1 on page 59) and on deploying vehicular sensors to increasingly challenging sites (higher clutter densities, more varied ordnance types). The man-portable systems can be deployed at challenging sites with variable topography or dense vegetation. Results from the 2011 demonstration at Beale Air Force Base indicate that these systems will provide similar improvements in classification as their larger antecedents.[12]

The large-scale field demonstrations ESTCP sponsored demonstrated the feasibility of significantly reducing the costs of UXO cleanup by deploying advanced sensor technologies coupled with classification algorithms. While the existing set of hardware tends to be heavy, bulky, power-hungry and relatively fragile, some systems have been transitioned to production companies undertaking large-scale UXO remediation projects. Another iteration in hardware development will be required before large numbers of field personnel possess rugged, lightweight and field-ready instrumentation. The future prospects for achieving significant reductions in the costs and time frames required for UXO remediation are extremely promising and worthy of future investment.

*See endnotes page 67*

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ENDNOTES

PM/WRA Director Jim Lawrence Retires, Leaves a Legacy by Crawford [ from page 6 ]


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25 August 2021

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# AICMA Helps Demine Nicaragua's Gocen District

The Gocen district of the Mateare municipality in Chiltepe Peninsula, 20 km (12 mi) outside of Managua, Nicaragua, was contaminated with explosive remnants of war from the artillery school that operated nearby. With support from *Acción Integral Contra las Minas Antipersonal* (Comprehensive Action Against Antipersonnel Mines, AICMA), a program of the Organization of American States, a large portion of the contaminated land in Gocen was cleared and released in 2012.

by Addison Embrey [ Monterey Institute of International Studies ]

Nicaragua's Sandinista Revolution (1974—1979) claimed 35,000 lives and the Contra War (1979—1990) claimed 43,000 lives, with a total death toll of 78,000 people after the two conflicts.[1] Although the Esquipulas II Accord was signed in August 1987, a cease-fire was not achieved in Nicaragua until 1990.[2] Guerrilla groups and military forces left behind landmines and unexploded ordnance throughout the country, including UXO at training sites such as the one at Gocen. By the end of 2011, there were-known casualties due to landmines, UXO and other devices (92 killed/1,207 injured).[3]

The roughly 600 residents who reside in the Gocen district were subject to this daily threat. The current inhabitants retired from the army before settling on the lands at Gocen near Lake Xiloá. Their petitions to the government resulted in the legalization of the plots they claimed. Community coordinator, Geovanny Pastora facilitated among the different entities involved, and each family received an average of roughly 1 hectare (2.5 ac) of land. This land however, had formerly belonged to the Nicaraguan Army School of Sergeants (noncommissioned officers), and students used it as a firing range to practice artillery gunnery. When the settlers began working the land, they realized that UXO littered the area. Because the district is considered impoverished, concern arose that citizens would collect explosive remnants of war to sell as scrap for income, increasing the risk of injury or death.[3]

Members of Nicaragua's Army Engineer Corps use UPEX-740 metal detectors to find unexploded ordnance in Chiltepe, Gocen district, Nicaragua.
*All photos courtesy of the Organization of American States.*

The Organization of American States partnered with the Nicaraguan Army Engineer Corps and Golden West Humanitarian Foundation to conduct a land rehabilitation project. Residents from the communities within the Gocen district experienced firsthand how they, their local authorities, the Nicaraguan military, OAS and the

Unexploded ordnance cleared from land in Gocen district, Nicaragua.

GWHF transformed lives through effective collaboration. OAS provided political and diplomatic support for the project. *Integral Contra las Minas Antipersonal* (Comprehensive Action Against Antipersonnel Mines, AICMA) partnered with GWHF to conduct technical field surveys and training, and the Nicaraguan Army Engineers provided equipment and personnel support.

### AICMA

In 2011 an individual from the Gocen district was injured when UXO detonated near him. In the following days, the communities in the district filed a joint complaint when 37 additional items of UXO were discovered in the surrounding area. Military officials reviewed the complaints and rapidly coordinated with the OAS program, AICMA.

AICMA assistance to Nicaragua dates back to 1991 when AICMA and Nicaragua developed a national demining plan after the country requested assistance from the Secretary General of OAS. Of Nicaragua's 15 departments, 14 were found to be contaminated with anti-personnel mines.[4] The national demining project took about 19 years to complete. Entire minefields were discovered within a kilometer of at least 284 communities. In total, an estimated 181,000 AP mines were emplaced over 1,029 areas throughout the country.[5] In April 2010 Nicaragua completed its national demining plan and declared Nicaragua and the entire region of Central America mine-free.

**Mine-free**, however, does not refer to other UXO left from the conflict or related activities. Since 2010, the OAS program has designed projects to assist Nicaragua in destroying 258,086 munitions of varying types and calibers, a total exceeding 900 tons. In 2011 AICMA helped clear 721,900 sq m (178 ac) of land in Las Palomas in the Matagalpa department. In completing these clearance projects, AICMA focused on three fundamental pillars: victim identification and assistance; prevention and response to reports; and rehabilitation of cleared land.

### Gocen District: A Success Story

During the preliminary stages of the Gocen district project in 2011, which involved establishing long-term relationships with affected communities, AICMA proposed a plan to conduct clearance of those plots of land presenting the greater risks to the community. AICMA and Nicaragua's Corps of Engineers drew upon past in-country accomplishments and experiences. In the international development world, best practice is the duplication and modification of previous experiences to produce similar results. To clear contaminated lands, the communities in Chiltepe peninsula also received technical assistance and consulting services from GWHF. Specific to Chiltepe, GWHF trained Nicaraguan military engineers on how to operate the UPEX-740 metal detector, a novel large-loop device to locate buried caches.

The residents of the Gocen district provided their knowledge of the area and guided experts and officials to the UXO. This helped to set the priorities for clearance, minimized the risk of the operation to the military engineers and demonstrated how the local residents—who make a living from the land—played an active role in building their community's future. This specific, sustainable and unique aspect of the project is one of the main reasons why OAS member states continue requesting AICMA's assistance.

In addition to coordinating priorities in clearance operations, AICMA also conducted community liaison at the Gocen district, working to obtain support for the project from the general population and community leaders. Also, because the Gocen District could not be cleared completely at the time with available resources, AICMA conducted awareness campaigns to encourage safe behaviors among local youth, the most at-risk group in the region.

In July 2012 the project was completed and the immediate surrounding area declared safe. The project consisted of clearing an area of 79,142 sq m (20 ac) and the subsequent removal of 909 items of UXO that were discovered, of which 904 were high caliber and 47 were unstable. In addition, more than 6,000 pieces of metal debris were discovered and removed during the clearance process. The land has since been turned over to the Gocen district communities; the military, AICMA and GWHF no longer operate in the area.

According to the OAS–AICMA project coordinator, as of 2012, 10 plots of land were successfully cleared, and local residents began cultivating crops. Local actors and residents of the Gocen district, the Nicaraguan Army Engineer Corps, AICMA, civil society and GWHF worked together to remedy the contamination from an otherwise productive land, working toward a landmine- and ERW-free future for Nicaragua. The collaborative leadership exemplified in this project is a success story. Here, the accumulated momentum will help encourage needed clearance operations in the future. Through the AICMA program, which was responsible for implementing munitions clearance and land remediation in the Gocen district, Chiltepe peninsula, OAS helps other member countries fulfill their national demining goals and collaboratively destroy remnants of war.

*See endnotes page 73*

*The author would like to thank Carlos José Orozco, AICMA's Regional Coordinator for Central America, for his assistance with this article. Note: Mr. Orozco, in coordination with Nicaragua's Corps of Engineers, devised the land rehabilitation project in Nicaragua's Gocen district.*

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Faces of Mine Action: Manizha Rasheed Kamal by Ober [ from page 68 ]

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AICMA Helps Demine Nicaragua's Gocen District by Embrey [ from page 70 ]

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Landmine survivors participate in activities at CISR's "Pathways to Resilience" psychosocial rehabilitation workshop in Lebanon in 2011. *Photo courtesy of Kamel Saadi.*

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