Cover Photo

Quality assurance for the Underwater UXO Clearance of Lake Ohrid, Republic of Macedonia, is conducted by PED Sava d.o.o., Kranj, Republic of Slovenia. The project was funded by the Office of Weapons Removal and Abatement in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/WRA) under the project management of ITF Enhancing Human Security and implementing partner Republic of Macedonia Protection and Rescue Directorate (RMPRD). During three unexploded ordnance (UXO) clearance phases, RMPRD divers cleared more than 26,000 sq m of Lake Ohrid’s bottom using underwater metal detectors and additional 30,000 sq m using visual detection. Altogether more than 19 tons of UXO were safely removed and destroyed.

Photo courtesy of Mr. Esad Humo, PED Sava d.o.o.

Contributors
Marian Bechtel
Daniel Braun
Emanuela Elisa Cepolina
Michael Creighton
Anna Crowe
Bonnie Docherty
Jo Durham

Thao Griffiths
Martin Jibens
Atle Karlson
Edward Lajoie
Nguyen Thi Thuy Nga
Ted Paterson
Vicki People
Mohammed Qasim
Elena Rice
Ken Rutherford
Andy Smith
Allen D. Tan
Blake Williamson

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Please direct all Journal submissions, queries and subscription/CFP requests to:
Lois Carter Crawford, Editor-in-Chief
Center for International Stabilization & Recovery
James Madison University
800 S. Main Street, MSC 4902
Harrisonburg, VA 22807 / USA
Tel: +1 540 568 2503
Fax: +1 540 568 8175
Email: cisreditor@gmail.com

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Dear Readers,

This issue of *The Journal* covers a wide variety of interesting and timely explosive remnants of war (ERW) and mine action topics, including unplanned explosions and weapons security, underwater clearance, survivors’ rights affecting Asia and the Pacific, and research and development studies.

For example, in an article by Elena Rice of the U.N. Mine Action Service, the author contends the mission of the mine action community must expand to include weapons and ammunition security. Discussing victim assistance and disability rights of survivors in Asia and the Pacific, Jo Durham (University of Queensland) emphasizes the importance of securing health care rights for survivors in Cambodia, Laos and Vietnam, while Nguyễn Thị Thúy Nga reflects on how the Association for the Empowerment of Persons with Disabilities, which employs ERW and mine survivors as outreach workers in Vietnam, successfully helps survivors reintegrate into their communities. Allen Tan of Golden West Humanitarian Foundation discusses the threat of contamination from sunken watercraft littering Cambodia’s rivers and tributaries, and how Golden West is addressing the problem by identifying and training suitable candidates for underwater training. In addition, the online edition of *The Journal* has additional articles, and we suggest you access our current issue online.

Besides producing this publication, the Center for International Stabilization and Recovery (CISR) is busy providing programs and training at James Madison University and abroad. For instance, CISR recently wrapped up our ninth Senior Managers’ Course in ERW and Mine Action (SMC). Currently supported by the U.S. Department of State, the SMC provides mine action program managers an innovative and challenging curriculum covering a broad range of topics to improve participants’ management skills—from conventional weapons destruction, victim assistance, physical security and stockpile management to strategic management, public relations and emerging trends in the post-conflict recovery arena. This year we had the honor of hosting 14 participants from 13 countries, bringing our total to more than 270 participants from 46 countries, including the mine action and ERW sessions we conducted in Jordan and Peru. We plan to continue with the SMC program next year (check the CISR website in winter 2013 for application details).

We are continuing our work with peer-to-peer support programs in Burundi and are moving into new areas of program management, including advocating for the rights of persons with disabilities in Vietnam and providing mine risk education to Syrian refugees in the Middle East.

As we share our lessons learned in future issues of *The Journal*, we encourage you to send us articles detailing your best practices and lessons learned as well. Our fall issue of *The Journal* is an exciting one, focusing on survivor assistance, along with current conflicts and the evolving landmine/ERW situations in the Middle East, including Syria. We look forward to hearing from you.

Sincerely,

Ken Rutherford

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Abandoned Ordnance in Libya: Threats to Civilians and Recommended Responses

In a report released in August 2012, “Explosive Situation: Qaddafi’s Abandoned Weapons and the Threat to Libya’s Civilians,” researchers from Harvard Law School’s International Human Rights Clinic (IHRC) examined Libya’s abandoned ordnance problem and its humanitarian consequences for the local population.1,2 Based on field and desk research, the report documents the threats these weapons pose, analyzes steps to address them and offers recommendations to minimize civilian harm. IHRC co-published the report with the Center for Civilians in Conflict (formerly CIVIC) and the Center for American Progress. In this article, two of the report’s authors summarize its 2012 findings and recommendations.

by Bonnie Docherty and Anna Crowe [Harvard Law School]

Vast quantities of abandoned ordnance have littered Libya since the end of the 2011 armed conflict.3,4 Munitions, ranging from bullets and mortars to torpedoes and surface-to-air missiles, have been scattered around inadequately guarded bunkers; local militias have gathered stockpiles in urban areas; and individual civilians have collected weapons for scrap metal or souvenirs. Determining the scale of the problem is difficult, as Moammar Gadhafi’s regime acquired an arsenal worth billions of U.S. dollars.2 Moreover, the regime’s weapons were divided among dozens of ammunition storage areas, each containing 25–140 bunkers.5

Many experts express concern over the international proliferation of these weapons, but the abandoned ordnance has also posed serious domestic threats to civilians. The report “Explosive Situation: Qaddafi’s Abandoned Weapons and the Threat to Libya’s Civilians” documents these dangers and examines the key activities needed to minimize them: stockpile management, clearance, risk education and victim assistance. As a foundational step, the Libyan government should create a coordinated and comprehensive national plan eliminating the “government confusion” generated by competing agencies and facilitating the four areas of work.5 In addition, the international community needs to provide ongoing and increased assistance and cooperation. The prevention of more civilian casualties requires urgent and immediate efforts by national and international entities.

Threats to Libya’s Civilians

During its field mission to Libya, Harvard Law School’s International Human Rights Clinic (IHRC) documented five major threats that abandoned ordnance has posed to civilians.6 Each of them has the potential to lead to additional civilian casualties.7

Stockpile locations. The positioning of stockpiles in populated areas coupled with poor management practices have increased the risk of catastrophic explosions that would cause significant injury and death. In March 2012 a member of the Military Council of Misrata, where this practice has been particularly common, estimated that in his city more than 200 militias each held between six and 40 shipping containers full of weapons.8 In the same month, an explosion in Dafniya, a town 20 km (12 mi) from Misrata, exemplified the danger. A militia had stored weapons in 22 adjacent shipping containers, and a stray shot reportedly penetrated one of the containers, detonating the ammunition in a chain reaction and spreading explosive remnants of war (ERW) across the neighborhood. A mine from the blast later killed a DanChurchAid deminer, and in late March the community was again using buildings in the affected area.6,10

Curiosity. Inquisitiveness has further endangered civilians who visit contaminated sites or handle abandoned weapons. Children are particularly curious and unsuspecting, and they have often played with munitions. A Danish Demining
Group manager observed that children “try to set off the anti-aircraft missiles with nails and bricks,” and IHRC learned of multiple casualties resulting from such behavior.11

Harvesting weapons materials. Civilians have been killed or injured while harvesting scrap metal to sell or explosives to use for fishing. For example, a man and his two sons died during an explosion in the Zintan ammunition storage area while gathering scrap metal in December 2011. The man’s family later asked a MAG (Mines Advisory Group) deminer to clear piles of collected metal and propellant from the family’s home.12

Community clearance. Since the conflict, abandoned and unexploded ordnance has contaminated homes, public buildings (such as schools and mosques) and farmland. Eager to make their communities safer, some civilians have tried clearing areas without expert training or assistance, an activity that endangers them and exacerbates the challenges of professional clearance.

Displays of mementos. Finally, war museums and private individuals have put weapons on display. The museum in Misrata, located on the city’s main street, has exhibited a large collection of weapons in a relatively haphazard way. Demining organizations have worked to make such museums safe; however, the museums have undermined risk education efforts by normalizing the collection of weapons and subsequently encouraging private displays, which deminers cannot monitor.

Stockpile Management

Since the end of the 2011 armed conflict, proper stockpile management has been sorely lacking in Libya, but good practices are essential to minimizing the threats of abandoned ordnance to the Libyan people.13,14 International organizations and the national government’s Libyan Mine Action Center (LMAC) have worked together to conduct surveys, and some local authorities have agreed to measures to improve practices.15,16,17 Progress has been limited, however. Unstable and inadequately secured weapons have remained in bombed ammunition storage areas, temporary storage facilities and militia shipping containers.

Poor stockpile management practices have abounded. Max Dyck, the former U.N. Mine Action Service (UNMAS) program manager in Libya, reported in July 2012 that ammunition storage areas, littered with munitions that were kicked out of bunkers by NATO bombings, had no real security.3 As a result, civilians have had access to the weapons. Furthermore, local militias have used dangerous storage methods, such as keeping different types of ammunition together and placing stockpiles within populated areas. A reluctance to give up weapons acquired during the armed conflict has interfered with U.N. and nongovernmental organization (NGO) efforts to improve management practices and destroy unstable weapons. In addition, funding for stockpile management initiatives has been insufficient, and coordination within the national government, between national and local government, and among the militias has been inadequate.

As a sovereign state, Libya bears the primary responsibility for dealing with its stockpiles. While it is engaged in a time of political transition and has many pressing concerns, Libya...
should develop the national plan discussed above. In addition, it should take specific steps to reduce the humanitarian threats caused by poor stockpile management. For example, Libya should do the following:

- Allocate more resources to improving stockpile practices
- Increase physical security at ammunition storage areas
- Prioritize coordination with militias to move stockpiles out of populated areas
- Initiate a program for building technical expertise within Libya
- Request international assistance to help put these steps in place

Remedial Measures: Clearance, Risk Education and Victim Assistance

To maximize civilian protection, a trio of remedial measures—clearance, risk education and victim assistance—should complement improvements in stockpile management. After the conflict, UNMAS and international NGOs took the lead on clearance efforts.16 These groups, however, have not received support from the Libyan government, have not had enough explosives to undertake controlled demolitions, have had difficulty finding staff with technical expertise and sometimes have faced obstacles when accessing sites. Groups have also expressed concerns about the lack of local capacity to take over future clearance activities.

International NGOs have played a role in risk education and worked closely with local risk educators. They have held sessions raising awareness of the dangers of abandoned ordnance and other ERW, distributed brochures, set up regional ERW-information hotlines, placed billboards on streets and created radio messages.19,20 Handicap International and MAG told the IHRC team that they have also cooperated with the Ministry of Education to train school teachers to provide risk education.21 These NGOs have received some additional assistance from LMAC (part of the Army Chief of Staff’s office) and the Libyan Civil Defense.24

Risk educators have faced several challenges, including dangerous attitudes toward weapons, particularly among children; difficulties in reaching influential audiences (especially women, who play a key role in educating their families about ERW risks); insufficient funding and the need to increase capacity in Libyan civil society to undertake further risk education activities.

As of July 2012, Libya had no established assistance program dedicated to the victims of abandoned weapons and other ERW. However, the broader assistance program for war victims, which is run through the Libyan Ministry of Health, has helped those harmed by ERW.25

Libya, as the affected country, bears primary responsibility for these remedial measures. In addition to developing a national plan, it should do the following:

- Increase its allocation of resources
- Promote capacity building and assist with the growth of local civil society
- Help deminers obtain explosives for ERW destruction and facilitate access to contaminated sites for clearance
- Ensure its victim assistance program follows international standards articulated in the Plan of Action on Victim Assistance under Protocol V on ERW to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects24

International Cooperation and Assistance

The four areas discussed previously—stockpile management, clearance, risk education and victim assistance—require significant resources and expertise, so international cooperation and assistance is critical to protecting civilians from the threat of these weapons.

As of July 2012, the international community had provided more than US$20 million to address ERW in Libya, but
that assistance was decreasing while the threats to civilians remained.\textsuperscript{25,26,27} To address the situation adequately, Libya needs increased and ongoing assistance.

During the conflict, NATO launched an estimated 440 airstrikes on ammunition bunkers. Rehabilitating a single bombed-out bunker can cost more than US$1 million, not including security walls, fences and lights, or clearance of the ordnance scattered in the attack.\textsuperscript{3} While financial contributions are valuable, assistance can also come in the form of material or technical support.

As a result, all states, even those with a limited ability to give financial assistance, should be in a position to provide some kind of assistance.

NATO and its member states should accept special responsibility to provide cooperation and assistance to address the abandoned ordnance problem related to bombed ammunition bunkers. Although lawful, NATO airstrikes on the bunkers contributed to the ERW situation. NATO assistance would be consistent with the emerging principle of “making amends,” under which a warring party provides assistance to civilians harmed in the course of lawful combat operations. Finally, such assistance would be consistent with the mandate under which NATO intervened in Libya’s armed conflict: the protection of civilians.

Conclusion

Due to the scale of Libya’s abandoned ordnance situation, solving the problem is a monumental task. The weapons have already killed or injured civilians, and more casualties are almost guaranteed. Libya and the international community must therefore urgently develop a coordinated response seeking to minimize this humanitarian threat. As a member of Libyan civil society told IHRC, the country needs “more cooperation between all parties—all the way from NATO to the man who lives next to the abandoned ordnance.”\textsuperscript{28} If successful, such coordinated action could not only reduce the loss of life in Libya, but also serve as a model for dealing with abandoned ordnance in other post-conflict situations.\textsuperscript{6}

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Weapons and Ammunition Security: The Expanding Role of Mine Action

Significant expertise is necessary to meet the security challenges posed by unsecured and poorly stored weapons and ammunition. To address this threat, many donors and mine action actors, including the United Nations Mine Action Service, are including weapons and ammunition security management as a core role.

by Elena Rice [United Nations Mine Action Service]

On 27 November 1944, an underground bunker holding 4,000 tons of ordnance detonated at the Royal Air Force Fauld underground munitions depot in Staffordshire, England. The explosion was the largest non-nuclear explosion ever recorded, leaving behind the Hanbury Crater (120 m deep [394 ft] and 1.2 km [1,312 yd] wide). While the exact death toll is unknown, approximately 70 people died.1 Time and time again, accidental explosions at ammunition storage facilities have caused death and destruction. For example, in Nigeria in 2002 an armory explosion claimed 1,100 lives. In 2012 in the Republic of the Congo (ROC) 282 people were killed, and children at a nearby school were spared only because the explosion occurred on a weekend.2

The human tragedy of these events highlights the importance of preventive measures against unplanned explosions.
However, the immediate impact is compounded by what is arguably a more widely catastrophic byproduct of improperly stored stocks. The medium- to long-term security threat posed by unsecured munitions holds exponentially more dangerous potential for destabilizing countries and regions, with serious implications for international peace and security. Proliferation of weapons and ammunition during and in the aftermath of recent conflicts starkly reveals the dangers of unsecured arms and ammunition. As Moammar Gadhafi’s government gradually lost control over Libya in 2011, opposition forces and other groups gained access to unsecured depots. Looted weapons have since been traced to Gaza, Somalia, and West and North Africa. The U.N. Security Council stated in December 2012 that “the continued proliferation of weapons from within and outside [the Sahel] threatens the stability of states in the region.” Weapons proliferation fuels insurgency, with the 2012–2013 crisis in Mali clearly demonstrating the impact of poorly stored and easily accessible weapons.

**Stockpile Security**

With the U.N. General Assembly calling for “practical measures” to mitigate this threat, the international community increasingly recognizes the challenge and calls upon states to make realistic assessments of the potential security risks of their stockpiles, while appealing to states in a position to do so to assist those with less developed capacity. Ensuring the physical security of storage facilities reduces the possibility that these weapons will be removed and used for nefarious purposes, including as components of improvised explosive devices. The role of the mine action community in alleviating this risk is apparent and the need to focus resources into practical implementation in the field is increasingly recognized.

The United Nations Mine Action Service (UNMAS) involvement in weapons and ammunition security management draws upon its ability to contribute expert skills, specialized equipment, and experience with explosive hazards. Several UNMAS-implemented projects focus on securing weapons and ammunition first and storing the materials second, emphasizing simple preventive measures such as perimeter fencing around formal and informal storage areas. For instance, with the program in Misrata, Libya, UNMAS placed secure storage containers inside the existing ammunition storage areas (ASA), which were too large to secure quickly. Implementing nongovernmental organizations (NGO) conducted clearance inside the ASA to provide space, then added fencing to increase security around the portion of the ASA that was cleared. While extensive damage has already been
done in terms of weapons proliferation from Libya to regional conflicts, these measures, implemented at the local and national levels, address the ongoing threat in the context of Libya’s efforts to restore public security.

The U.N. program in Côte d’Ivoire represents a pivotal success for mine action-driven implementation of weapons and ammunition management. The HALO Trust (HALO), with UNMAS coordination, worked with Ivorian security forces to rehabilitate a majority of the country’s storage facilities. National technical capacity was strengthened to such an extent that the state became a regional model for safe and secure ammunition storage and is increasingly called upon to share experience and technical expertise. In a strong display of South–South cooperation, Chad, the Democratic Republic of the Congo (DRC) and the ROC visited Côte d’Ivoire in 2012 to learn from its experience and apply the country’s methods in the implementation of their own national weapons and ammunition management operations.

UNMAS made strong headway in accessing peacekeeping and political funds for weapons and ammunition management, successfully advocating to the U.N. Department of Peacekeeping Operations and U.N. Department of Political Affairs that unsecured munitions threaten security and stability and fuel terrorist activities. As a result, the U.N. missions in Côte d’Ivoire, DRC, Libya and South Sudan have allocated specific funding to UNMAS for projects that address security and storage. UNMAS has in turn coordinated and implemented these activities through NGOs, such as HALO, MAG (Mines Advisory Group) and the Swedish Civil Contingencies Agency. As circumstances demonstrate the necessity for similar projects in Mali and other conflict-affected countries, the trend of including weapons and ammunition security management funding in peacekeeping budgets will likely continue.

The Expanding Role of Mine Action

The term mine action implies that the work focuses solely on landmines. Many states and NGOs have long advocated that explosive remnants of war (ERW) and small arms/light weapons (SA/LW) need to be looked at in unison. For
example, the U.S. Department of State initiated a comprehensive approach to conventional weapons destruction (CWD) incorporating mines, ERW and SA/LW, as well as physical security and stockpile management (PSSM) with the consolidation of several related offices into the Office of Weapons Removal and Abatement in 2003; other states have also adopted this approach.

An important step in educating the disarmament-focused diplomatic community was the participation of UNMAS and several mine action NGOs, including MAG and Handicap International, in the Programme of Action on SA/LW in September 2012. For instance, UNMAS presented a side event at the conference: “Preventing big bangs and saving lives” focused on UNMAS work in Cote d’Ivoire and Libya. “Practical implementation lessons: armory and stockpile assessment in Africa” was organized by the U.K.’s Foreign and Commonwealth Office and MAG. These efforts represent progress in encouraging member states to adopt an expanded mine action role. However, more remains to be done before the mine action community is recognized as a key implementer, supporting the weapons and ammunition management agenda.

All mine action actors are responsible for lobbying, advocacy and re-branding their wide range of work (to include all mine action, CWD, PSSM, SA/LW and weapons security issues) as critical for both security and development.

Second, sufficient and sustained funding is essential to the predictability and effectiveness of interventions; however, gaining access to funds remains a challenge for those implementing mine action. Mine action implementers must continue to engage in outreach efforts, establish new links with these entities and lobby states likely to fund projects in affected states.

Mine action work has traditionally been funded through a dedicated governmental department for mine action or by offices dealing with humanitarian funding. Meanwhile resources for weapons and ammunition management projects are frequently derived from different departments focusing on disarmament, nonproliferation, security and stabilization. Clear exceptions exist, for example the U.S. State Department has consolidated CWD and PSSM funding in one combined budget. Likewise U.K.’s Department for International Development has generously funded arms and ammunition management alongside conventional mine action in combined projects. We hope that this trend will continue.

By securing weapons and ammunition, the mine action community can prevent their proliferation and misuse by nonstate actors. This role for mine action is becoming increasingly recognized by U.N. member states. However, more work remains, including accessing new resource pools and expanding or re-branding the mine action mission to correspond with the widening spectrum of its activities. UNMAS stands ready to assist with these efforts.

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The views expressed in this article are those of the author and do not necessarily represent the views of the United Nations.
Cluster Munition Remnant Survey in Laos

As the most heavily bombed country per capita in the world, clearance of cluster munition remnants is a long and ongoing process in Laos. Norwegian People’s Aid developed survey methodology to address the unique challenges posed by cluster munition contamination.

by Michael Creighton, Atle Karlsen and Mohammed Qasim [Norwegian People’s Aid]

The clearance community traditionally uses structured surveys to locate and evaluate the extent of contamination from cluster munitions and explosive remnants of war (ERW). However, Norwegian People’s Aid’s (NPA) involvement in Southeast Asia over the last few years suggests current practices should be analyzed for effectiveness and subsequently updated. Traditional practices focus on battle area clearance and all types of unexploded ordnance (UXO). In Cambodia, Laos and Vietnam, NPA focuses on the more commonly occurring cluster munition remnants (CMR) in its method for UXO clearance. However, NPA’s method still considers and incorporates efficient ways to detect other UXO and ERW.

When trying to define the extent of the problem with surveys, CMR present a different challenge than landmines. CMR have unique characteristics, which differ from other types of UXO and landmines. For instance, due to the lack of extensive ground warfare in Laos, the incidence of considerable fragmentation affecting detector use is infrequent and manageable. CMR also fall into more identifiable patterns than other UXO due to the deployment method. These patterns can be searched for during Technical Survey (TS). Additionally, CMR have a relatively high failure rate, making the pattern of deployment identifiable in ways that mines are not.

The duration of CMR contamination can also affect a traditional survey’s ability to define the problem. Recent cluster munition strikes may provide clear footprints that can be surveyed rapidly and tasked for clearance, whereas assessing the location and extent of contamination for older strikes is more challenging. Changes in the vegetation and landscape, deterioration of CMR and interference from local populations, such as villagers completing partial demining efforts, often make the location and extent of contamination difficult to assess. This presents survey and clearance organizations with the challenge of identifying where to start and stop clearance.

For survey and clearance organizations using clearance requests from the local population as the only element of survey in their operational land release systems, the challenge of when to start and stop is not often adequately addressed. While the information the local population provides forms a large part of Non-technical Survey (NTS) and TS efforts, it
should not determine confirmed hazardous areas (CHA) or where to employ clearance assets. Survey decisions based solely on requests from the local population typically involve extremely large areas that sometimes encompass entire villages. Recording a suspected hazardous area (SHA) or CHA is not acceptable unless the area has a proven, valid claim of contamination. Clearing an unconfirmed area as if it is a CHA wastes significant time, funding, and effort. In contrast to the advances made in mine action over the last decade, many contaminated countries rely on civilian informers to relay locations and the extent of contamination. However, CMR require a more professional, rigorous approach.

A New Approach

Demining organizations need to compile data gathered from the local population into a more thorough and professional NTS and TS system, using local information as well as other indicators and survey methods to determine how best to clear CMR. In the case of cluster munitions, their specific types and methods of deployment can be used to develop other methodologies for NTS and TS approaches.

CMR have contaminated Laos for almost 50 years. Prolonged exposure to weather causes CMR to become increasingly volatile, which makes determining the extent of contamination difficult. Due to high levels of contamination, CMR evidence is prevalent throughout most of the country; however, determining the extent of each area of contamination is difficult. This uncertainty prohibits deminers from focusing clearance assets in the contaminated areas. By sourcing local information, NTS can determine where survey efforts should begin. These start or evidence points are identified and used to target the TS, which then determines the extent of the contamination in that area and creates a CHA. The CHA is reported to the national authority for addition to the national contamination database (in the case of Laos, the National Regulatory Authority or NRA).

Because determining where to start may be more manageable than determining where to stop or where to deploy clearance assets, NPA developed the CMR survey methodology in Laos to address the latter two issues.

Background Information

NPA found that evidence points may be more difficult to identify in countries with contamination similar to Laos, where contamination may be disturbed or partially exposed (e.g., some areas of Vietnam). In these cases, the existence of verified CMR in an area, determined through NTS, may be used as the start point for the TS effort.

Due to the lack of extensive ground warfare in Laos, battle areas requiring area clearance on the surface or at shallow depths are rare, and spot tasks are sufficient to destroy individual pieces of ordnance. However, there are vast areas where large bombs reside deep underground, and these are usually not encountered unless a particular development project requires deep excavation. If an area experienced ground warfare and received extensive contamination, a CHA may be created relative to the extent of the visible contamination. This is rare in Laos, as most contamination near the surface usually consists of cluster munitions and should be addressed through different methodologies.

Technical Survey

To address CMR contamination in the most efficient way possible, NPA developed a system of TS that takes into account the unique characteristics of cluster munitions contamination in Southeast Asia, including the high metal signature of cluster munitions (i.e., footprint) and the ability to walk with relative safety through a suspected area. NPA uses a rapid
survey technique to effectively determine the extent of the contamination before clearance assets are employed.

In this process, the initial non-technical phase of the land release process is conducted through village meetings and review of existing documentation. Instead of identifying SHAs, the NTS records evidence points for both CMR and other UXO in the area. All evidence points identified in a given area (e.g., within the boundary of a village) are assigned to UXO spot task teams, while CMR evidence points are addressed by CMR survey teams.

Once the CMR survey (i.e., the TS phase of the land release process) is complete, a CHA polygon is formed around the contamination evidence and reported to the NRA as a CHA.

When clearing a CMR-surveyed site, in addition to clearing the CHA, a 50 m (54 yd) fade-out area, the agreed distance from a specific evidence point where the TS/clearance is carried out, is adopted from the outer-most bomblets found within the CHA polygon.4 The area cleared within the polygon, which includes any cleared, fade-out areas that extended outside of the polygon, is classified as released ground. The rest of the area surveyed during the CMR survey, while determining the CHA, is classified as area surveyed only. This area is not released as there was never a confirmed claim of contamination from which to release it.

Notably, to release land, there must have been an actual confirmed claim of contamination. As a means of surveying an area, visual observation cannot confirm contamination or release land. Likewise, an area determined by a request-based system should be considered a SHA and not a CHA. The SHA can be cancelled; when the actual contamination within the SHA has been determined through TS, it would then become a CHA. In the CMR survey methodology a SHA is not created, as it would be artificial. The TS process commences from a confirmed evidence point, and a CHA is created through the TS activity.

CMR Survey

The CMR survey methodology is based on existing evidence (e.g., a bomblet or a valid claim of contamination) and involves rapidly surveying 2,500 sq m (2,990 sq yd) boxed areas or boxes beyond the initial evidence point. CMR survey determines which boxes contain evidence of contamination. Five surveyors are assigned to each box, and they use UXO detectors (e.g., Vallon VMXC1-3) set to maximum sensitivity. The surveyors move through the box in a systematic manner, under the direction of the section commander. If extensive metal contamination is encountered in any area, the area is skipped and the survey moves to an adjacent area. The purpose of the CMR survey is to paint a general picture of the contamination in the area, with which surveyors can create a CHA.

If surveyors find a bomblet, survey in that boxed area is terminated and the box is recorded in red. If the surveyors find fragments of CMR (e.g., a fragmentation ball from a BLU...
especially significant in Southeast Asia, where the vegetation is a dominant limiting factor in any mine or UXO operation. The CMR survey methodology works efficiently in average levels of vegetation and only requires the ability of the detector head to be pushed through and around vegetation. In most cases, only minimal vegetation removal is needed for the CMR survey methodology to operate.

Conclusion

Developed by NPA, the CMR survey approach in Laos commenced in 2010 and the methodology was fully accepted in mid-2012. As the CMR survey process involves preliminary survey, suspected areas can be confirmed and recorded prior to targeted clearance, eliminating costly clearance of uncontaminated land. This process provides a clear estimation of clearance needs, and enables Laos to make more specific and accurate assessments of needed assets and donor funding. This requirement is difficult to achieve if survey/clearance organizations accept tasks based only on community requests, where the extent of contamination is unknown until clearance has been completed. Before the use of CMR survey, alternate surveys have resulted in expensive, superfluous searches that spent unnecessary assets without finding contamination.

Figure 4. Village contamination.
Michael Creighton holds a Bachelor of Arts in politics and a Master of Arts in international relations from the University of New South Wales (Australia). He served 11 years as an officer in the Royal Australian Engineers before establishing himself as a project operations and planning manager in the explosive ordnance disposal and mine action fields in 2001. Creighton has since worked in Afghanistan, Bosnia and Herzegovina, Cambodia, Iraq, Laos and Lebanon in a variety of commercial and United Nations Mine Action Service positions. From 2009 to 2011 Creighton held the position of programme manager for land release at the Geneva International Centre for Humanitarian Demining. In 2012 he joined Norwegian People’s Aid (NPA) and is currently the operations manager of NPA’s Survey and Clearance Programme in Laos.

Mohammad Qasim is a skilled mine action information management and geographic information systems specialist and has more than 15 years’ experience with various mine action programs around the world. Qasim has worked with Norwegian People’s Aid (NPA) since 2009. Qasim is currently based in Laos as the regional information management supervisor, providing information management services to NPA’s Southeast Asia programs in Cambodia, Laos, Myanmar (Burma), Thailand and Vietnam, and assisting national authorities where NPA is engaged in national capacity development.

Atle Karlsen
Country Director/Policy Advisor
Norwegian People’s Aid
368 Unit 20
Ban Saphanthong, Sisattanak District
Laos
Tel: +856 207 744 7000
Fax: +856 21246813
Email: atlek@npaid.org
Website: http://npaid.org

Mohammad Qasim
Regional Information Management Supervisor
Norwegian People’s Aid
368 Unit 20
Ban Saphanthong, Sisattanak District
Laos
Tel: +856 202 221 2802
Fax: +856 212 46813
Email: qasim@npaid.org
Website: http://npaid.org

NPA has found that CMR survey is the best survey approach in Southeast Asia and potentially for other cluster munition contaminated countries as well. Providing answers to questions of confirmation of contamination, it remains cost-efficient and presents an effective, low-tech clearance option that allows rapid implementation. NPA has already established more than 16 sq km (6 sq mi) of CHAs in Laos using the CMR survey approach (more than 238 CHAs of known and marked areas of contamination). These CHAs were the first to be entered into the national database, providing a basis from which the national authorities can set priorities and plan the use of clearance resources. See endnotes page 64

Atle Karlsen is the country director for Norwegian People’s Aid (NPA) in Laos. Karlsen holds a Master of Arts in development economics from the University of East Anglia (U.K.) and a Master in Management from the BI Norwegian Business School (Norway). Karlsen has worked in mine action for more than 10 years after “accidentally” getting involved in strategic assessment for NPA and conducting an evaluation of the global Landmine Impact Survey initiative. He has worked as regional director for NPA in South Africa and as a policy and strategy advisor to NPA prior to taking his current position in Laos. He is a board member of the International Campaign to Ban Landmines, the Cluster Munitions Convention and the Landmine and Cluster Munitions Monitor, and a co-chair for the United Nations and nongovernmental organization forum.

Mohammed Qasim
Regional Information Management Supervisor
Norwegian People’s Aid
368 Unit 20
Ban Saphanthong, Sisattanak District
Laos
Tel: +856 202 221 2802
Fax: +856 212 46813
Email: qasim@npaid.org
Website: http://npaid.org

See endnotes page 64
Assessment of Vietnam’s National Mine Action Program

A December 2012 assessment conducted by the Geneva International Centre for Humanitarian Demining and the Vietnam Veterans of America Foundation found that despite Vietnam’s well-received mine action program reform efforts, various factors, including economic and bureaucratic challenges, continue hindering progress.

by Ted Paterson [GICHD] and Thao Griffiths [VVAF]

Vietnam suffers from extensive landmine and explosive remnants of war (ERW) contamination as a result of the Vietnam War (1965–1973). Vietnamese officials maintain that ERW contamination covers one-fifth of Vietnam’s total land area, or 66,000 sq km (25,483 sq mi), and that an estimated 350,000–600,000 tons of ERW still need to be cleared.

Vietnam’s response to contamination has undergone a number of distinct stages:

- 2006–2010. On 29 April 2008, the government of Vietnam initiated mine action reforms, including the establishment of Vietnam Bomb and Mine Action Center (VBMAC), a civilian entity housed within the Ministry of Labour, Invalids and Social Affairs (MoLISA).

Financing Mine Action

VNMAP (also known as Program 504 in Vietnam as it was established in Decree 504 by the Prime Minister in December 2010) is funded primarily by its national budget and private investors, through four channels—the MoD, other ministries, subnational governments and private investors—as depicted in Table 1. A number of international mine action nongovernmental organizations (NGO) are active in Vietnam and generally work with provincial governments. International donors fund these NGOs. Grants from international donors such as Australia, Germany, Ireland, Norway, Taiwan, the U.K. and the U.S. averaged about US$6.1 million per annum in recent years and continue to rise.

Still, the bulk of funding comes from Vietnam’s national budget. Engineering Command—Vietnam’s headquarters for military engineering units, including demining units—reports that demining expenditures averaged US$20 million from 1979 to 2006, then rose significantly from 2006 to 2010, driven largely by a demand for demining support to infrastructure projects and private investments. The recession in 2011 led to a reduction in public and private investment, delaying implementation for a number of approved demining tasks.

<table>
<thead>
<tr>
<th>Source of funding</th>
<th>Decision-makers</th>
<th>Purpose</th>
<th>Service provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>National budget</td>
<td>Ministry of Defence</td>
<td>Military requirements</td>
<td>Military deminers</td>
</tr>
<tr>
<td></td>
<td>Other ministries</td>
<td>Public investment</td>
<td>Military</td>
</tr>
<tr>
<td></td>
<td>Sub-national governments</td>
<td>Provincial-district-commune investments</td>
<td>Local demining firms</td>
</tr>
<tr>
<td></td>
<td>Private investors</td>
<td>Private investments</td>
<td>Firms</td>
</tr>
</tbody>
</table>

Table 1. VNMAP’s funding channels.
All graphics courtesy of the authors.
VNMAP’s financing pattern is distinctly different from that in most other mine/ERW-affected countries (Figures 2, 3 and Table 2).

Outline of Recent Reforms

Evidence from the Vietnam Landmine Impact Survey (VLIS), as well as the World Bank and Asian Development Bank, suggests that VNMAP is effective in terms of development (e.g., support to public and private investment projects). However, the national program was not as effective in supporting humanitarian mine action for bottom-up initiatives of communities or for targeting clearance and mine risk education (MRE) services based on casualties incurred.

In addition, Vietnam was unable to attract international mine action support, in part because many donors refuse to finance activities undertaken by the MoD. Therefore, VBMAC initiated the reform with a demining capacity under MoLISA. VBMAC received some international funding, but this has been sporadic.

In 2010 the government approved an ambitious National Mine Action Program Plan for 2010–2025, with seven tasks set for the period of 2010 to 2015:

- Complete VLIS
- Conduct unexploded ordnance (UXO)/landmine clearance projects that support the government’s socio-economic development plans and ensure safety for the people
- Establish a national database center
- Develop the Vietnamese National Mine Action Standards
- Implement MRE programs
- Initiate victim assistance
- Raise international awareness of the scale of Vietnam’s contamination

In 2011, the government established and appointed members to a steering committee to oversee the VNMAP plan. The plan for 2010–2015 was extremely ambitious; financing requirements reached $110 million in 2011 and continue to rise in subsequent years to an annual average of almost $150 million. Implementation was successful on some components,
The results were reported in December 2012 at the Vietnam Mine Action Forum held 14 December 2012 in Hanoi. The assessment focused specifically on the views of international stakeholders.

Working with the Vietnam Veterans of America Foundation (VVAF), GICHD developed a simple questionnaire and distributed it primarily through email to donors, U.N. agencies, operators, government ministries and provincial authorities involved in mine action. Then, on a trip to the cities of Hanoi, Quang Tri and Hue in October 2012, an assessment team from VVAF and GICHD met with 19 organizations to review responses and ask follow-up questions.

The assessment team obtained 21 questionnaire responses which were broken down into the following categories:

- Operators (7)
- Donors (5)
- Government ministries/offices (5)
- Provinces (2)
- U.N. agencies (1)
- Consultants (1)

**Findings**

In brief, the assessment found that international stakeholders approved of VNMAP, but current progress disappointed them. More specifically, the majority of respondents were happy with VBMAC’s establishment in 2008 and with the announcement of a national program in 2010 for a variety of reasons, as these actions showed the following:

- Signified growing awareness within the Vietnamese government of the mine/UXO problem
- Included provision of MRE and victim assistance
- Suggested greater transparency and a level playing field (i.e., national standards that all operators would be required to meet)

such as VLIS, but progress was uneven overall. In some cases, the international community seemingly remained largely unaware of new initiatives launched by VNMAP.

**Assessment**

In June 2012 Vietnamese mine action officials requested that the Geneva International Centre for Humanitarian Demining (GICHD) undertake an assessment of VNMAP.
• Indicated that a balanced approach might emerge, with more demining targeted to support community development and reduce the number of victims.

Though the national program represented a significant advance, several flaws were noted, including the following:

• Vietnam’s unwillingness to join the Convention on Cluster Munitions
• The failure to make VBMAC fully civilian
• Lack of oversight, as VBMAC serves as both a national mine action center and as a demining operator

Most international stakeholders were unhappy with the rate of implementation for one or more components of the 2010–2015 plan. Specific concerns included the following:

• Delays in completing the national standards
• Failure to appoint full-time personnel to VBMAC
• Lack of communication by national officials

International stakeholders favorably mentioned a number of recent actions, including the attendance of VBMAC officials at Mine Action Working Group meetings and the meeting of the first Vietnam Mine Action Forum in December 2011.

Interestingly, most international stakeholders seemed unaware of progress on certain fronts. For example, they were not aware of MRE messages broadcast on television in Vietnam. Nor did they know that highly contaminated provinces received national budget transfers of approximately $7.5 million per year in 2011 and 2012 for demining projects.

Concerns raised most often were the continuing dependence of VBMAC on the MoD, VBMAC’s lack of progress in drafting national standards, establishment of a true mine action center and the absence of a national database center.

Operators emphasized that they worked closely with provincial authorities and were not fully aware of developments in Hanoi. Most said relations with provincial authorities were improving steadily; a few expressed concern that the new national program might create problems for operators because of additional registration requirements.

International respondents presented a number of hypotheses as to why implementation lagged:

- Recent economic downturn pushed mine action lower on the government agenda.
- Bureaucratic battles delayed progress (e.g., MoD wanted to keep full control of demining).
- Unresolved policy issues (e.g., the relative roles of national ministries and provincial governments) hindered implementation.
- Inaccuracies in initial assumptions and policies, and mine action officials now realize these should be amended (e.g., VBMAC should not have been created as both a regulator and an operator).

**National Stakeholders**

National stakeholders focused more on the work that has been done to get VNMAP operating, and mentioned the following:

- Progress on VLIS and MRE
- Establishment of a high-profile steering committee
- Transfers from the state budget to provinces to fund demining projects

The Ministry of Planning and Investment also emphasized that mine action is a priority for both official development assistance and in its priorities issued to donors. Ministry officials also spoke of plans for 2013 that awaited Prime Minister Nguyen Tan Dung’s approval. These include the following:

<table>
<thead>
<tr>
<th>Year</th>
<th>Financing (dollars)</th>
<th>Total funding</th>
<th>International as % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Government &amp; investors</td>
<td>International grants</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>$ 49.50</td>
<td>$ 3.95</td>
<td>$ 53.45</td>
</tr>
<tr>
<td>08</td>
<td>$ 69.50</td>
<td>$ 7.64</td>
<td>$ 77.14</td>
</tr>
<tr>
<td>09</td>
<td>$ 84.17</td>
<td>$ 4.20</td>
<td>$ 88.37</td>
</tr>
<tr>
<td>10</td>
<td>$ 116.70</td>
<td>$ 7.07</td>
<td>$ 123.77</td>
</tr>
<tr>
<td>11</td>
<td>$ 50.73</td>
<td>$ 7.89</td>
<td>$ 58.62</td>
</tr>
</tbody>
</table>

Table 2. Annual financing requirements for VNMAP 2011–2015.
Ted Paterson has a background in international development, working with nongovernmental organizations, research and education institutes, and consulting firms, as well as in an independent consultant capacity. Paterson has been active in mine action since 1999 and has worked on socioeconomic and performance-management issues. Paterson joined the Geneva Centre for International Humanitarian Demining in 2004 and serves as senior advisor on strategic management. He has a Bachelor of Commerce from the University of Manitoba (Canada), a Master of Arts in economics from York University (Canada) and a Master of Science in development economics from the University of Oxford (U.K.).

Ted Paterson
Senior Advisor, Strategic Management
Geneva International Centre for Humanitarian Demining
7bis, avenue de la Paix
P.O. Box 1300
1211 Geneva 1 / Switzerland
Tel: +41 22 906 1667
Email: t.paterson@gichd.org
Skype: gichd.t.paterson
Website: www.gichd.org

Thao Griffiths has been the country director of Vietnam Veterans of America Foundation’s (VVAF) Vietnam office since 2007. Previously, Griffiths worked as the senior Vietnamese program officer at VVAF and also held positions at Microsoft and the United Nations Development Programme. Griffiths holds a Master of Arts in international relations from American University (U.S.) and a Master of Science in systems engineering from Royal Melbourne Institute of Technology (Australia).

Thao Griffiths
Vietnam Country Director
Vietnam Veterans of America Foundation (under the International Center)
No 20, Ha Hoi St
Hanoi / Vietnam
Tel: +84 4 733 9444
Email: tgriffiths@ic-vvaf.org
Skype: thaogriffiths
Website: http://www.ic-vvaf.org/

• Establishment of a national regulatory office
• Division of VBMAC to create a new Viet Nam Mine Action Coordination Centre (VNMACC) and a separate civilian operator
• Appointment of qualified personnel to VNMACC on a full-time basis and to a new location

Assuming approval is obtained, these plans address the majority of the concerns raised by stakeholders.

Conclusions
While VNMAP’s approval was widely welcomed, the pace of implementation disappointed many stakeholders. The division of roles and responsibilities among MoD, VBMAC and the proposed regulatory office remains unclear to most stakeholders, and this represents a significant concern to those involved. Contributing to disappointing progress on other measures envisaged, the delay in providing adequate human and financial resources to the mine action center is a core problem. However, better progress can be expected in 2013 and beyond, assuming that the plans and budgets already prepared are approved.

See endnotes page 64
Securing Health Care Rights for Survivors: Developing an Evidence Base to Inform Policy

Analysis of current literature on landmine/explosive remnants of war casualties in Cambodia, Laos and Vietnam reveals flaws in recording systems. An integrated course of action should aid mine action and public health communities in preventing incidents and providing care to survivors.

by Jo Durham [University of Queensland]

The United Nation’s Convention on the Rights of Persons with Disabilities (CRPD), adopted by the General Assembly in December 2006, aims to promote and protect the rights of people with disabilities (PWD). It recognizes that PWDs have the right to the highest attainable standard of health without discrimination, and should be able to access the same range, quality and standard of free or affordable health services as people without disabilities, as well as any specialized health resources they may require. The protections of the CRPD, however, only apply in countries that have become states parties to this convention. The rights of landmine and cluster munition survivors are further protected by 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) and the Convention on Cluster Munitions (CMC), again, only in states that sign and ratify these conventions.

In order to fulfill these international obligations, a consistent and comparative description of injuries, risk factors and comorbidities is required to inform the health decision-making and planning processes. This is especially important as a substantial number of nonfatal injuries result in permanent disabilities, which can put significant strains on existing health care systems. Valid estimates are also needed to calculate the cost-effectiveness of interventions.

Using Cambodia, Laos and Vietnam as examples, the World Health Organization (WHO) significantly underestimates landmine and explosive remnants of war (ERW) injuries. It is important to note that only Laos is a state party to the CRPD and CMC. Cambodia is a state party to the
APMBC, but not the others. Vietnam is not a state party to any of these conventions; Cambodia and Vietnam have signed but not ratified the CRPD. Nevertheless, this underestimation of landmine/ERW injuries means that survivors are more likely to be excluded from health systems planning, and this has important ethical and social justice implications.

Estimates of Mine/ERW Injury-related Fatalities

The author systematically studied the peer-reviewed health literature examining landmines and ERW deaths and disabilities in Cambodia, Laos and Vietnam, finding only six relevant studies. One of the articles focused on Laos while the remaining five examined Cambodia’s situation. Of the six studies, five were undertaken before 1996. Furthermore, four of the studies relied on hospital data and did not capture a large proportion of deaths. Table 1 summarizes the papers and main findings of each.

No studies were found that focused on Vietnam in peer-reviewed literature. However, WHO Global Burden of Disease (GBD) studies for Vietnam reported 20,008 casualties between 1974 and the end of 2007. Shown in Table 1, this is a much higher estimate than reported in the Laos study. In its 2004 WHO GBD study for Laos, WHO reported 60 deaths. In the same year the Lao National Regulatory Authority (NRA) recorded 294 incidents, which resulted in 117 deaths—almost twice the WHO estimate. In 2008, the Lao NRA reported 99 ERW deaths, while WHO reported no fatalities. The WHO GBD 2004 study for Cambodia reported 127 deaths, whereas the Cambodia Mine Victims Information System (CMVIS) reported 171 deaths. More agreement was seen in the WHO and CMVIS findings in 2008. The data for each country was rated as Level 4, which means country-specific information on cause of death is unavailable. Therefore, the casualty estimates are based on mathematical models. In other words, WHO does not use injury data from the mine action community in estimating landmine/ERW injuries and thus significantly underestimates the burden.

Most available data is based on dichotomous outcome measures, i.e., being alive or dead. Nonfatal injuries have a

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Type</th>
<th>Sample method/size</th>
<th>Year of study</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersson, Dasousa &amp; Paredes, 1995</td>
<td>Cambodia</td>
<td>Population based</td>
<td>N=6,090</td>
<td>1994, 1995</td>
<td>• 432 civilian injuries • 51.3 per 1,000 males aged 15-44 • 61% in debt to cover health costs</td>
</tr>
<tr>
<td>Morikawa, Taylor &amp; Persons, 1998</td>
<td>Laos</td>
<td>Population based</td>
<td>Each village head interviewed, N=276 villages</td>
<td>Not stated</td>
<td>• 870 civilian injuries • 70% male • 46% &lt; 15 years of age</td>
</tr>
<tr>
<td>Bendinelli, 2009</td>
<td>Cambodia</td>
<td>Review of trauma database</td>
<td>All patients admitted within timeframe, N=356</td>
<td>2003–2006</td>
<td>• 6.4% &lt; 16 years of age, mean age = 11.6 (+/-2.8), mostly due to UXO • 73.6% adults mean age = 32.5 (+/- 11.1), mostly due to landmines</td>
</tr>
<tr>
<td>Jackson, 1996</td>
<td>Cambodia</td>
<td>Clinic based</td>
<td>All blind patients admitted within timeframe, N=453</td>
<td>1994</td>
<td>• Bilateral blindness due to trauma, n=14</td>
</tr>
<tr>
<td>Husum et al., 2002</td>
<td>Cambodia</td>
<td>Clinic based</td>
<td>Consecutively injured survivors with severe injury, N=25</td>
<td>Not stated</td>
<td>• Male n=19, female n=6 • Mean age = 36 • Chronic pain in survivors n=12</td>
</tr>
<tr>
<td>Stover, Keller, Cobey, &amp; Sopheap, 1994</td>
<td>Cambodia</td>
<td>Clinic based</td>
<td>All landmine patients hospitalized between Jan. 1990 and June 1993, N=842</td>
<td>1993</td>
<td>• 85% male • 7% female • 8% &lt; 15 years • Mean age = 29</td>
</tr>
</tbody>
</table>

Table 1. Summary of findings in peer-reviewed literature. Table courtesy of the author.
wide scope of severity. These injuries can range from insignificant scratches to needing ambulatory medical care, hospitalization for major surgery or permanent disability. As a result, only measuring whether people die or are injured masks the true burden.

**Ongoing Needs**

Most landmine/ERW survivors are between the ages of 15 and 49 and live their remaining years with some level of disability. With an estimated life expectancy of 59 years in Cambodia, for example, a male injured at 15 may live for an additional 44 years with a disability. Where injury results in traumatic amputation and requires a prosthesis, the prosthesis will need changing several times. A 15-year-old male landmine survivor in Cambodia, who requires prosthesis, will need approximately 11 prostheses replacements in his lifetime. Furthermore, in malaria-endemic areas, post-injury malaria is a common complication to injury and surgery, resulting in an extended recovery.

Survivors often suffer multiple injuries that may include ruptured eardrums, blindness, loss of function, loss of mobility and chronic pain. These are also risk factors for high levels of psychological distress. In turn, psychological distress is a risk factor for harmful health behaviors, such as hazardous drinking and increased smoking, which also may increase the future risk of diseases. This factor underscores the public health issue, revealing that the total breadth of landmine/ERW injury extends beyond fatalities. If the true burden of landmine/ERW injuries is invisible to health systems, service providers will be poorly equipped to address survivors’ needs in the immediate and the long-term, particularly in countries with high levels of infectious disease.

Out-of-pocket health expenditure associated with ERW injury and related comorbidities is high. When combined with loss of productivity, this financial stress can represent a catastrophic economic burden to a household, creating a downward spiral into poverty, malnutrition and disease. Permanent disability or losing a parent also has a significant impact on the future health of children and limits their educational and economic opportunities. Thus, injuries resulting in permanent disability also incur high social and economic costs, profoundly altering the lives of survivors and their families. Reducing injuries would contribute to policymakers achieving their economic objectives at the micro and macro level, as well as ensuring survivors’ rights are met. If healthy individuals will more likely be productive individuals, it also follows that the children of healthy parents will more likely complete at least primary and/or secondary level education and become economically productive adults.

Continuing to underestimate the true burden from landmine/ERW injuries perpetuates the perception that landmines and ERW impairments are not a significant health-policy issue. If the injuries incurred from the explosives were distributed equally across all ages of the population, then this strategy may be appropriate. However, injuries are mainly concentrated in male adolescents and the working
population, many of whom also belong to low socioeconomic groups. Measuring injuries in age groups and communicating epidemiological facts to health policymakers is a necessary step to ensure the legal rights of survivors are met, as articulated in international conventions. This will also ensure that survivors are not discriminated against due to a paucity of accurate data.

What Is Needed?

To understand the true extent of landmine/ERW disabilities, injuries need to be systematically accounted for in the health care system. This requires mine action and public health communities to cooperate to meet the needs of survivors and reduce micro and macroeconomic impacts through the following:

- Surveillance of community-based injury data compatible with the Information Management System for Mine Action and health information systems.
- Clarification and standardization of the coding of multiple injuries and their severity.
- Collection of accurate incidence and prevalence data including mapping.
- Analysis of age-specific demographic details and risk factors as different groups have different exposure patterns.
- Measurement and attribution of noncommunicable diseases or other disabilities linked to landmine/ERW injuries.
- Measurement of the impact of multiple concurrent infections and chronic morbidities.
- Use of the standard disability-adjusted life years (DALY) to measure the impact of disease and disability. One DALY represents losing one year of full health. Using DALYs, diseases/injuries that cause early death but little disability (e.g., drowning) can be compared to diseases/injuries that do not cause death but do cause disability.
- Research and evaluation of interventions with lessons learned translated into practice and tailored to local contexts and circumstances.
- Study of loss of work productivity and impact upon person/family/community.
- Analysis of the cost-effectiveness of reducing injuries.

Opportunities

More attention is focused on the issue of injuries in low-income and middle-income countries. Health planners recognize that without investing in injury and prevention programs, the impact of other major investments in low- and lower-middle-income countries is likely to be lost. In post-conflict environments, the burden of landmine/ERW injuries should be included in the injury prevention agenda, especially as most nonfatal injuries result in permanent disability and affect particular segments of the population.

To conclude, an effective and coordinated public health response is required to prevent and manage landmine/ERW injuries and meet legal commitments under the CRPD, the APMBC and the CCM. To ensure that the legal rights of the affected populations are met, these injuries should not remain invisible in national burden of disease estimates and should not be excluded in health systems planning.

See endnotes page 65

Jo Durham has worked in various positions in mine action for more than 10 years. She teaches Health and Development and Health Aspects of Disasters at the University of Queensland (Australia). Durham completed her doctorate in International Health at Curtin University (Australia). She holds a master’s in international health from the same university. Her doctoral studies included an examination of the livelihood impacts of landmine/ERW clearance. Her other research interests are injury prevention, disability and related comorbidities.

Jo Durham
Lecturer, Health and Development/Health Aspects of Disaster
University of Queensland
School of Population Health
Australian Centre for International and Tropical Health
Herston Rd.
Herston QLD 4006 / Australia
Tel: + 07336 55341
Email: durhamjo@yahoo.com; m.durham@uq.edu.au
Website: http://uq.edu.au/uqresearchers/researcher/durhammj.html
Association for Empowerment of Persons with Disabilities in Quang Binh, Vietnam

The Association for Empowerment of Persons with Disabilities (AEPD) was established in May 2010 to continue the work of Survivor Corps in rural Vietnam. AEPD uses peer support to empower persons with disabilities who have sustained mine, explosive remnants of war or other war-related injuries. This approach employs survivors, who have successfully reintegrated into communities and recovered from psychosocial trauma, as peer-outreach workers. AEPD staff host training workshops, partner with local health clinics, assist in creating self-help groups and provide economic opportunity activities. AEPD also leads landmine advocacy action in Vietnam.

by Nguyễn Thị Thúy Nga [AEPD]

Vietnam, one of the most heavily bombed countries in the world, has a large disabled population.1 Approximately 5 million people, or 6.3 percent of the Vietnamese population, live with a disability.2 Since 1975, unexploded munitions have killed or seriously wounded more than 100,000 Vietnamese. Even in 2010, nearly 40 years after the Vietnam War ended, 42 landmine and explosive remnants of war (ERW) casualties were reported in only two of the country’s 58 provinces.3,4 Quang Binh, one of Vietnam’s poorest provinces, has around 40,000 survivors and persons with disabilities (PWD), many who survived bombing raids, cluster munitions detonations, landmine explosions or Agent Orange. The majority of Vietnamese PWDs live in rural areas on incomes below the poverty line. Economic, social and environmental barriers prevent most PWDs from fully participating in society.

To preserve the legacy of Survivor Corps, an international humanitarian organization that operated in Vietnam from 2003–2010, the Association for Empowerment of Persons with Disabilities (AEPD) was established as a local nongovernmental organization (NGO) on 31 May 2010 under Decision No. 1177/QD-UBND by the Provincial People’s Committee.5 AEPD is committed to continuing Survivor Corps’ mission by embracing its values of equality and inclusion, and helping PWDs meet their health and economic needs in the target areas of Quang Ninh, Dong Hoi, Quang Trach, Bo Trach, and Le Thuy districts of Quang Binh province.
AEPD’s programs aim to improve the psychological, physical, and economic well-being of PWDs, including those who were injured and disabled by landmines or ERW or have other war-related injuries. To achieve this goal, AEPD developed and applied a survivor-centric approach that focuses on peer support. AEPD runs the only comprehensive rehabilitation program in Quang Binh province.

Peer Support Methodology

AEPD operates with a 15-member staff, including seven amputees who are peer-outreach workers. Peer-outreach workers are excellent role models for other survivors, because they have successfully recovered from the psychosocial trauma related to their injuries, reintegrated into their communities and gained employment. AEPD’s outreach workers learn to provide psychosocial and emotional support to other survivors recently injured or suffering from trauma.

During peer-support visits, peer-outreach workers help survivors identify recovery goals and carry out activities required to achieve these goals. Peer support is provided to survivors for no more than 24 months, after which survivors “graduate” and resume their positions in the community.

From 6 to 8 March 2012, AEPD and the Center for International Stabilization and Recovery (CISR) at James Madison University cooperated to implement a training workshop on peer support for PWDs in Vietnam. CISR Director Kenneth Rutherford and Trauma Rehabilitation Specialist Cameron Macauley led the three-day workshop, which provided an excellent opportunity for 39 PWDs in Quang Binh to enhance their skills and improve their basic understanding of providing peer support to others. During the training, most of the participants committed to applying and transferring this methodology to other PWDs in their community. AEPD has documented this peer-support methodology for application not only in Quang Binh but also in other provinces in Vietnam with an aim of expanding the program. Peer support training greatly enhances AEPD’s success in working with PWDs.

Ongoing Efforts

Since 2003, AEPD has reached out to approximately 2,850 landmine survivors and more than 2,650 PWDs. AEPD has assisted 950 households with economic opportunity activities, established 30 self-help clubs for PWDs with more than 1,000 members and upgraded 15 local health clinics with needed equipment and tools.6 Easing economic, psychological and social constraints, AEPD provides opportunities for PWDs in poor communities by expanding business models in order to generate increased income. Moreover, PWDs are taught soft skills and given peer counseling and referrals to
other resources—such as relatives, the community, the local government, other NGOs, etc.—that can help mobilize funds. Alternatively, self-help clubs are set up on a volunteer basis, and the local authority legally approves them. These are different from peer-support groups. AEPD offers start-up grants of up to US$4,000 to eligible PWDs to start businesses. By training existing health trainers, AEPD has also enabled local health clinics to conduct more than 27 training courses on rehabilitation techniques. Moreover, with the recent addition of the 2010 National Disability Law, the situation for disabled people is improving as the law is considered a legal basis for the increased empowerment of PWDs.

During the past several years, AEPD has also led the work of the Landmine Working Group in Vietnam on advocacy issues, related to Vietnam’s signing of three international treaties affecting survivors’ lives:

- *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 APBMC)
- *The Convention on Cluster Munitions* (CCM)
- *The Convention on the Rights of Persons with Disabilities* (CRPD)

In addition, AEPD successfully organized and chaired an advocacy workshop on the CCM with the Department of Foreign Affairs in Ho Chi Minh City. AEPD also cooperated with the Provincial People’s Aid Coordination Committee to organize the first national workshop, Victim Assistance and International Cooperation in Vietnam, on 7 July 2009.

AEPD faces several challenges in Quang Binh, one of the poorest provinces in Central Vietnam with a large population of disabled people. These challenges include providing psychosocial and economic support to 40,000 PWDs; spreading awareness of disability rights and issues; reaching disabled people in remote locations; and operating peer-support programs amid funding limitations. Despite these challenges, AEPD hopes to continue mobilizing funds from multiple donors and advocating for the CRPD, APMBC and the CCM. With grant support from donors including Irish Aid, Norwegian Ministry of Foreign Affairs, Survivor Corps, United Nations Development Programme, Swiss Solidarity, and others, AEPD continues with Survivor Corps’ mission, providing peer support to landmine survivors and other PWDs to improve their quality of life through access to health care, economic opportunity, social empowerment, advocacy and community-based, disaster-risk management.14

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Without his limbs, Ve focused on his other abilities; his vision seemed to become clearer, his hearing keener and his thinking sharper. Ve organized job after job. These ranged from charging motorbike batteries, providing transportation services, grinding stone for construction, repairing cars, planting trees, and small construction projects. Through his tireless efforts, Ve gradually built a business empire for himself.

When I met Ve, he was guiding a massive cargo truck to a parking area to replace its tires. Then he gave me a tour of the Duc Ve Enterprise building. With AEPD’s financial support of 150 million dong (US$7,186), Ve built the center and organized a vocational training center for PWDs. With support from the Department of Labor, Invalid and Social Affairs and the Department of Industry and Commerce of Quang Binh (provincial level), Ve offered job training courses on making incense, candles and votive objects. To date, Ve has conducted four courses and trained 250 people, including disabled people, homeless children and the poor. Participants can come from any province or district to learn sustainable skills to support themselves, just as Ve did. Currently, Ve employs four PWDs. Working at the center is one of Ve’s most rewarding jobs, and creating it for PWDs fulfilled one of his long-term goals.

In addition to the vocational training center, Ve manages two motor repair shops that employ a staff of 10 workers, each earning a monthly salary between three and six million VND per month (US$143.70 and $287.40 as of 4 October 2012). Ve is also involved in several other business ventures, including scrap-metal collection, construction material trade, afforestation, small-scale construction, and mechanical vocational training.

Ve’s outreach continues to grow. He has gained popularity in recent years through appearances on well-known VTV1 channels, Chao Buoi Sang (Good morning) and Nguoi Xay To Am (Warm Nest Maker), and through his advocacy for PWDs in national and provincial meetings. Having created a successful life for himself, Ve believes that economic empowerment is the best way for other survivors to overcome feelings of inferiority and create independent lives for themselves.
Mass Fitting for Amputees in Tam Ky

The VietNam Assistance for the Handicapped (VNAH), a U.S.-based nongovernmental organization founded by Ca Van Tran, provides prosthetic devices and wheelchairs for victims of explosive remnants of war in rural communities in Vietnam. Ken Rutherford and Cameron Macauley of the Center for International Stabilization and Recovery participated in a mass prostheses fitting led by VNAH in Tam Ky, Vietnam. In the article, Rutherford describes the impact this event has on nearly 200 men and women.

by Kenneth Rutherford, Ph.D. [Center for International Stabilization and Recovery]

On 9 March 2012, my colleague, Cameron Macauley, a trauma rehabilitation specialist from the Center for International Stabilization and Recovery at James Madison University, and I had the good fortune to participate in a mass fitting for amputees in Tam Ky, Vietnam. When we arrived, some 200 men and women awaited their turns to have plaster casts made for manufacturing new, durable and very comfortable prostheses. They removed their old prostheses, and I was astonished by these ancient, handmade artificial legs constructed of wood, rubber, wire and cloth. Most of them had been broken and repaired numerous times.

We were invited by Ca Van Tran, founder and president of VietNam Assistance for the Handicapped (VNAH), a U.S.-based nongovernmental organization that sponsored the outreach event. Tran regularly visits communities in rural Vietnam to offer free prosthetic devices and wheelchairs to people with disabilities. He uses much of his personal money to support programs for people with disabilities in Vietnam, and is interested in opening new projects in Myanmar (Burma).

“A new arm, leg or wheelchair makes all the difference in the world for these people,” says Tran. “It makes work, play and everyday activities possible, and allows them to live with dignity and self-respect. Nothing gives me greater joy than to see an amputee walk with grace, pride and comfort. Even though the situation is improving for people with disabilities in Vietnam, much more needs to be done.”

The March event was an opportunity for amputees to be fitted for new prostheses to be manufactured in VNAH-supported prosthetics workshops in Da Nang. Tam Ky is home to many people affected by the Vietnam War and the explosive remnants of war resulting from it; however, access to modern mobility devices is difficult. Of the 200-plus amputees at the event, nearly all used worn, outdated, homemade prostheses. Poorly made devices of this type are uncomfortable to use and often lead to skin breakdown on...
a residual limb as well as chronic back pain and joint problems.

After each amputee was fitted for a new prosthesis by having a plaster cast made of their residual limbs, many were transported to the Da Nang workshop where they received new prostheses carefully customized to their needs. They also spent some time undergoing physical rehabilitation and learning to walk with the new device. Amputees who required upper-limb prostheses learned to use their new hands to dress and feed themselves and to ride a bicycle or a motorbike. All of these services were provided free of charge.

These amputees are men and women who have lived for decades without the benefit of tough, comfortable prosthetic limbs that tolerate physical abuse and exposure to weather. Their residual limbs are calloused and scarred from chafing inside poorly fitted sockets. I saw their joy and relief at the thought of working, playing and taking a relaxing stroll without feeling the pinch and cramp of a barely adequate prosthetic leg.

I lost my legs to a landmine in Somalia in 1993; I know what it means to walk on artificial legs. I have met thousands of amputees in countries worldwide, and I know how important these new limbs are to them. VNAH is providing mobility, comfort, safety and even beauty to the lives of these Vietnamese, many of whom never dreamt that they would ever be lucky enough to receive a new prosthesis. It was a wonder and a profound delight for me to see such kindness in action.

Tran recognizes the value of being able to walk with dignity and grace, run after a soccer ball and have a leg that will not buckle under your weight. Thank you, Tran, for your dedication to people with disabilities in Vietnam and around the world, and to your efforts of making their lives easier and better.

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Kenneth R. Rutherford, Ph.D., is director of the Center for International Stabilization and Recovery and professor of political science at James Madison University. He holds a doctorate from Georgetown University (U.S.) and received his Bachelor of Arts and Master of Business Administration from the University of Colorado (U.S.). His most recent book, Disarming States: The International Movement to Ban Landmines, was published in December 2010. He is also the author of Humanitarianism Under Fire: The US and UN Intervention in Somalia and has coedited two books: Landmines and Human Security: International Politics and War’s Hidden Legacy and Reframing the Agenda: The Impact of NGO and Middle Power Cooperation in International Security Policy.

Kenneth R. Rutherford, Ph.D.
Director
Center for International Stabilization and Recovery
800 South Main Street, MSC 4902
Harrisonburg, VA 22807 / USA
Tel: +1 540 568 2756
Email: rutherkr@jmu.edu
Website: http://cisr.jmu.edu
Addressing Underwater Ordnance Stockpiles in Cambodia

Cambodian rivers and tributaries contain vast amounts of munitions from sunken watercraft, and the task of locating and extracting these munitions is difficult. In response, Golden West Humanitarian Foundation designed a rigorous diver preparation course to train Cambodian nationals in advanced diving skills and basic recovery procedures needed to organize effective explosive ordnance salvage teams.

by Allen D. Tan [Golden West Humanitarian Foundation]

Ordinance in Cambodia’s rivers is not a new concern but is a growing problem due to potential misuse of recovered explosives by civilians and scrap-metal collectors. Various combatants in Southeast Asia used the Mekong and Tonle Sap rivers—along with their numerous smaller tributaries—as resupply routes during the conflicts of the 1960s and 1970s. Over time, some of these resupply vessels were lost, and their cargo lies on the bottom of Cambodia’s rivers.

These munitions remain mostly unfired and in shipping configuration. Because they are found in discrete locations, the term stockpile differentiates them from unexploded ordnance (UXO). Although Cambodia also faces the related problem of underwater UXO and individual munitions that were scattered across large areas, it is not the focus of this program. Issues of underwater UXO primarily affect infrastructure development projects such as bridges, where 100 percent clearance is required for underwater construction areas. While the submerged stockpiles provide substantial threats to the public, underwater UXO have a minimal impact on public safety and security.

Scrap Collection

In a country littered with landmines and UXO, underwater ordnance is still a major concern, even though it rests meters beneath the water’s surface. In Cambodia, this ordnance does not stay underwater. Civilians collect underwater stockpiles for scrap metal and explosives, which have economic value: People generally sell them on the black market for use in quarrying or fishing.

In 2007 local authorities asked the Cambodian Mine Action Center (CMAC) to assist with the cleanup of an illicit scrap-collecting operation site in Kandal province. Len Austin, an explosive ordnance detection technician from Golden West Humanitarian Foundation (Golden West) assisted the CMAC team. At the site, the scrap collectors had already recovered thousands of U.S.-made, 105 mm artillery projectiles and 81 mm mortars from an underwater stockpile. In typical fashion, the explosives were extracted by hand and the metal bodies sold for scrap. The extracted explosives were neatly organized by type in old rice sacks, ready for sale.

Although the public safety issues posed by UXO scrap collection are familiar to the humanitarian mine action community, the magnitude of Cambodia’s river stockpiles makes most comparisons inadequate. During an underwater detection trial, Golden West located a small, 1970s-era military resupply boat estimated to contain more than 20 tons of munitions. A scrap-collection operation capable of processing this quantity of ordnance is comparable to a small demilitarization plant that operates near public roads and disregards the surrounding population. Complicating matters, authorities do not know the locations for many of these underwater stockpiles. Unlike a surface munitions bunker, which can be guarded or monitored, these underwater stockpiles are not monitored. If ordnance goes missing, no one notices.

The Historical Record

From historical records, authorities know where and when some of the larger stockpiles sank. Foreign accounts from the 1970s state “60,000 tons of civilian and military supplies were shipped every month on barges and shallow-draft freighters.” This refers specifically to shipments from South Vietnam, up the Mekong river to the Port of Phnom Penh in Cambodia. During the war,
these river convoys were a lifeline that supported Phnom Penh from 1973, when insurgent forces cut off the city, until the capture of Phnom Penh in 1975.2

The river from the Vietnam border to the Port of Phnom Penh stretches approximately 97 km (60 mi). According to a report by Kenton Clymer, this section of river is the most heavily contaminated in Cambodia, with press and historical documents suggesting that the area is contaminated with more than 2,000 tons of munitions.3

**Recovered Ordnance Condition**

Time will not resolve this problem. Golden West’s Explosive Harvesting Program (EHP) technical staff examined the condition of the munitions firsthand in two cases where they received samples of munitions recovered from underwater stockpiles.

Bulk explosives recovered in the 2007 Kandal province scrap collectors’ raid were tested and found to be completely functional. In 2010 EHP disassembled complete projectiles from a small boat found on the bottom of the Tonle Sap. The ordnance was in exceptional condition and still exhibited fully intact factory safety stickers on the projectile bodies after having been submerged in 10 m (11 yd) of water for more than 30 years. In both cases, the explosives were in such good condition that EHP used them to produce humanitarian demining charges.

**Locating Stockpiles**

Regarding containment, the first challenge involves stockpile location. Once located, two principal options exist: full recovery or site monitoring (which prevents unauthorized recovery). While site monitoring is
theoretically possible due to the visible footprint that even makeshift dive operations present, the lack of police manpower, cost and other challenges in implementation make this approach untenable. Full recovery is the best solution.

Scrap collectors find underwater stockpiles through several methods known to authorities, none of which involve sophisticated equipment. The first method involves offering monetary incentives to locals living in riverside villages who witnessed the watercrafts sinking. These riverside residents also may have recovered a few items themselves for scrap when times were tough. Similarly, local fishermen know where sunken vessels are located because fish congregate around these wrecks.

In Cambodia, Golden West developed a systematic survey-based approach that incorporates a variation of the low-tech methods described previously with technology that increases the productivity and reliability of results. Much like the scrap collectors, the Golden West team relies on locals for information about the ships and underwater obstructions. In Golden West’s experience, references to sightings can be off-target by several hundred meters, which is substantial when divers enter a zero-visibility environment. When directed by local fishermen, the locations tend to be more exact.

In either case, reports do not automatically warrant the deployment of a dive team, particularly when precise locations are unknown. This is when advanced technology is applied. Using sonar, Golden West can survey large areas of river very quickly. Any protruding anomaly will be immediately apparent.

Once the sonar locates an anomaly, teams must determine whether the anomaly has sufficient metal content to indicate the possibility of large quantities of ordnance. Due to the dynamic environment presented by Cambodia’s rivers (such as unregulated river traffic,
masses of floating vegetation and a high density of fishing nets), towing a conventional subsurface magnetometer is impractical. Golden West accomplishes underwater demining with a custom-designed sensor, based on the Ebinger UPEX 740 and mounted on a towed surface platform. With an array measuring 5 m by 5 m (5.47 yd by 5.47 yd), this pulse-induction detector can see large metal targets as deep as 30 m (33 yd).

The final component to this system involves verification, or reconnaissance divers. When a target with a significant metal signature is identified, divers are the only way to determine if that signature is attributable to ordnance. Other possible causes include engines or metal objects such as hulls or wheeled vehicles. If the diver investigation is inconclusive, the site is marked for possible salvage.

Building Cambodian Salvage Capacity

The unavailability of Cambodian assets capable of safely recovering underwater stockpiles prevents progress on this issue. Without the means to recover stockpiles, a systematic survey of the river bottom would be irrelevant. Working with CMAC, the U.S. Department of Defense (DOD) Humanitarian Mine Action (HMA) Program and the Office of Weapons Removal and Abatement in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/WRA), Golden West developed a strategy to build a national salvage dive capability.

Golden West’s first challenge was the lack of suitable Cambodian candidates to undergo dive training. Among host-nation nationals, insufficient swimming abilities and minimal-to-nonexistent formal education in math and science presented unique challenges. With this in
mind, Golden West developed the Diver Preparation Course, an intense physical and academic regiment intended to identify and train suitable candidates for advanced dive training. PM/WRA funded the course; it began 28 January 2013 in Phnom Penh.

Separated into two phases, Phase I of the Diver Preparation Course started with the basics of how to swim. Over a two-week period, candidates spent more than 30 hours in the pool learning basic strokes, snorkeling and other exercises designed to teach operational safety in an underwater environment. When not in the pool, students learned scuba vocabulary, physics, history, hand signals and underwater rigging. Forty applicants were accepted for Phase I; by test day, 34 candidates remained. 

From those 34 candidates, 20 students were selected during a formal selection process by a board comprised of all the instructors for Phase II based on their competence in and out of the water. Since all the students were already employees of CMAC and came from other jobs (mostly as deminers), those not selected to continue returned to their previous jobs.

Held in the seaside town of Sihanoukville, Phase II also lasted two weeks. Grueling 14-hour days were split between the classroom, the pool and the ocean. Students were instructed how to use scuba equipment in the pool and learned scuba theory in the classroom. Four hours of daily, strenuous, ocean-based confidence training tested the students’ physical conditioning and mental discipline. This training introduced them to the rough conditions that professional divers experience, instilling the mental strength needed to deal safely with exhausting conditions. Their performance was remarkable, given this was the first time many individuals had ever seen the ocean.

The second week of Phase II consisted of 18 working dives over six days at sea. During these dives, the students learned how to run a working dive station, conduct underwater searches and perform basic recovery procedures under blackout conditions. The main aim of Phase
II was to graduate divers capable of continuing to more advanced training. From the group of 13 students to complete this course, 10 graduated with the CMAC Second Class Diver rating and will form the first CMAC Salvage Dive Unit when funding becomes available.

Graduates from the Diver Preparation Course are not salvage divers. The next steps for the newly formed CMAC Salvage Dive Unit will be to continue building their capacity over the next one to two years. This will be accomplished through daily intra-unit trainings that maintain skills and periodic, short-duration training sessions from outside experts to build new skills. This new skills training regimen will be supported by the U.S. DOD HMA program, and the first Light Salvage Course is scheduled for June 2013. The U.S. Army’s 7th Engineer Dive Detachment from Hawaii will conduct this course.

**The Future of Salvage Diving**

Golden West currently seeks adequate funding to sustain the CMAC Salvage Dive Unit through its infancy and begin the systematic survey of the river system. The goal is to provide the CMAC Salvage Dive Unit with the tools to sustain readiness and perform operations without outside guidance. This process will take two to three years, including developing standard operating procedures for equipment maintenance, mission planning, recruitment and training.

The Cambodian Diver Preparation Course was initiated as a pilot program designed to test the validity of this training model. In order to refine the model for future iterations, considerable effort was made to record lessons learned. Operating as a mobile training program, this course could be applied in countries considering the development of a national dive capability. Golden West plans to extend this course to other countries looking to build their own dive program.

Golden West is the first nonprofit nongovernmental organization to partner with a national mine action agency and U.S. governmental agencies to address this new area of humanitarian mine action in Cambodia. One of Golden West’s key guiding principles is unity of effort, and this project fully supports the whole-of-government approach, bringing together PM/WRA, the U.S. DOD HMA Program, the U.S. Army, CMAC and the Cambodian Mine Action Authority. Golden West is pleased to have the opportunity to conduct this project and looks forward to making the region safer for the Cambodian people. 

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Going Mobile: Information Sharing and the Changing Face of Digital Data Collection

Effective crisis management requires current and credible information archives, but with limited resources and mobility, gathering such information proves difficult for humanitarian aid organizations and policymakers. Accessing real-time information means having the right tools at your disposal, and technology platforms like Frontline SMS and Ushahidi enable organizations to do just that at no cost.

by Edward Lajoie [Center for International Stabilization and Recovery]

In the fields of humanitarian mine action and victim assistance, governmental policymakers, nongovernmental organizations, and local mine action authorities constantly need accurate, current data that will aid them in successfully carrying out their missions. Insufficient information on local conditions and priorities leads to less effective responses as organizations seek to adapt to unforeseen obstacles and unknown variables, detracting from time spent on intended activities. To provide accurate, current information, more data must be gathered and analyzed. However, these activities require time and resources. When tools and processes are insufficient for organizing and analyzing data, organizations can become overwhelmed with raw facts.

Mine action organizations require a tool that not only facilitates the collection of data but the analysis of it as well. The community already has several excellent instruments for managing this task: The Information Management System for Mine Action (IMSMA) developed under the supervision of the Geneva International Centre for Humanitarian Demining (GICHD) is the most ubiquitous. Yet, another platform exists that mine action organizations should look into as an addition to their information collection and management toolbox.

Ushahidi

Ushahidi, which means testimony in Swahili, was originally created in 2008 as a response to Kenya’s post-election violence. The website mapped violent incidents and peace efforts in the country using reports from the web and mobile devices submitted by more than 45,000 users.

After the Ushahidi site’s initial success, it was developed into a downloadable platform, allowing users to collect data submitted via email, SMS (short message service, or text), Twitter and the Internet. This data can then be displayed on a map and tracked using a timeline feature. This platform is free to download on Ushahidi’s site and is open-source, meaning users can modify it to fit their specific needs.

Ushahidi’s product suite includes Swift River, a platform for curating and analyzing large amounts of data from real-time streams including Twitter and RSS (Really Simple Syndication) feeds, which is useful for information verification when dealing with the large amount of information that results from crowdsourcing data collection. For organizations in need of quicker results, Crowdmap also exists, a Web-hosted version of the original Ushahidi platform eliminating the need for the user to run their own server. Ushahidi differs from traditional data-collecting platforms in that the information represents the affected community in real time. Text reports can be submitted via email, SMS, Twitter or the Web and may include photos and videos. This data can be geographically (geo-) tagged and displayed on a map using Keyhole Markup Language (KML) georeferencing standards. By crowdsourcing data gathering, Ushahidi reaches a larger audience than traditional surveys and is more participatory: Community members actively contribute to their
own community and regional recovery by submitting data. Ushahidi continuously improves its accessibility with innovations such as a voice-messaging system, which allows nonliterate users to submit reports. In the wake of multiple natural disasters, Ushahidi’s platform was deployed by several humanitarian actors, providing updates and real-time mapping of everything from the extent of destruction to the availability of emergency services. For example, Ushahidi received particular recognition in the wake of the Port-au-Prince earthquake in Haiti on 12 January 2010.

Mine Action Applications

The mine action field could deploy the Ushahidi platform in many ways. One potential use is as an additional method for community members in remote areas to report unexploded ordnance (UXO) or landmine contamination. After a mine risk education (MRE) team or a community liaison briefs the community on how to submit a report, the locals could quickly and easily submit a warning via SMS, detailing the location of a landmine or UXO.

The reports would not replace any existing protocols. This technology would be an additional tool that could facilitate community interaction, increasing the speed at which people report landmines and UXO. This method of reporting could be particularly useful in a conflict zone where Non-technical Surveys cannot be conducted due to ongoing violence. Similarly, it could track injuries caused by mines or UXO, especially in conflict situations where traditional records are hard to maintain and distribute.

This tool may also be a valuable resource for the victim assistance community. Encouraging persons with disabilities to submit reports on the availability and effectiveness of health care services in their area could allow organizations to build a data set of care providers and determine which areas to target with service provision, as well as determine what type of assistance is most needed, by using the mapping feature gained from analyzing the actual reports.

Challenges

Ushahidi is not a perfect tool, however, and organizations evaluating it for potential use should consider some issues.

Information accuracy. One main concern is the verification of information received via crowdsourcing. While Phuong N. Pham and Patrick Vinck, senior research scientists at Harvard School of Public Health’s Department of Global Health and Population, point out that accuracy, precision and manipulation are valid concerns for this collection method, they also note that a number of approaches, or information
forensics, are developed to address the issue and provide effective verification mechanisms. Ushahidi also includes an information-verification guide on its website along with other resources that teach new users how to employ the platform.

**Privacy concerns.** Privacy concerns, specifically reports dealing with health, also need consideration. The researchers addressed this issue in their own platform Outbreaks Near Me, a swine flu (H1N1 virus) tracking application, by re-coding any health-related data. A secure server stored personally identifiable data, but any public data was anonymized. Organizations will have to find ways to alleviate privacy concerns individually, based on the type of data they collect and the environment in which they work.

Ushahidi will not replace more advanced information-management systems such as IMSMA, but it should be considered an additional tool for organizations looking for a cost-effective way to gather and analyze data. Ushahidi’s flexibility and orientation toward community participation makes it a good tool for gathering information in rapidly evolving situations where traditional data-collection methods are hard to employ. The ability to receive reports via SMS is essential for environments without Internet access, and Ushahidi’s online hosting of data sets, available by request, facilitates cooperation between communities and the organizations working to help them. Mine action and victim assistance organizations would be remiss if they do not seriously consider integrating the Ushahidi platform into their information-management systems.

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**Ed Lajoie**
Assistant Project Manager & Research Specialist
Center for International Stabilization and Recovery
800 S. Main St., MSC 4902
Harrisonburg, VA 22807
Tel: +1 540 568 5202
Email: lajoieem@jmu.edu
Website: http://cisr.jmu.edu

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**News Brief**

**WWII Cleanup: Munitions Contaminate German Seas**

—Dan Braun, CISR staff

During World War II Nazi forces began dumping chemical and conventional weapons in the ocean to avoid devastation by enemy aerial bombings. Following the Nazi Party’s unconditional surrender in May 1945, the Allied powers continued with this practice to dispose of German arsenals. Munitions from WWII still pollute German coastal waters, mainly the result of large-scale weapons-dumping between 1945 and 1948. According to Germany’s Program on Underwater Munitions, eight dumpsites in the North and Baltic Seas contain 1.6 million metric tons of aerial mines, bombs, shells and unexploded ordnance (UXO). Of these, roughly 14 percent, or 230,000 tons, are chemical munitions.

Since 1947, hundreds of Danish fishermen have been injured by mustard gas munitions mixed in with their catches. In 2005, three fishermen caught a bomb in their nets and were killed when it exploded on the vessel.

Decaying mustard gas barrels similar to these found underwater in the U.S. Gulf of Mexico have been found in German seas.

Photo courtesy of Texas A&M University.
Making It Relevant: Risk Education in the Democratic Republic of Congo

For many years MAG (Mines Advisory Group) has delivered risk education in the Democratic Republic of the Congo (DRC) through its humanitarian mine action programs. In 2012 MAG evaluated its educational methodologies and their effectiveness on different target groups in DRC.

For years, risk education has been a central component of humanitarian demining activities. Key to communicating the dangers posed by the presence of mines and explosive remnants of war (ERW), risk education can significantly reduce the risk of accidents before clearance takes place.

MAG (Mines Advisory Group) has delivered risk education to affected communities in the Democratic Republic of the Congo (DRC) since 2006. Working through dedicated community liaison teams, MAG has gained significant experience and seen firsthand the positive impact that risk education can have on communities still suffering from the effects of conflict.

Recognizing that a one-size-fits-all approach is rarely effective in any educational activity, MAG developed an array of tools and techniques to allow a tailored approach for delivering risk education to various groups in communities. These range from formal presentations for nongovernmental organizations and national authorities to focus group discussions with rural women. MAG continually develops new methodologies in response to changing needs and realities in mine-affected communities.

Evaluating Approaches

With funding from the U.K.'s Department for International Development (DFID), a recent project implemented from February to June 2012 sought to examine how diverse approaches to risk education delivery can produce different levels of learning among various target groups. Findings from this project allowed MAG to evaluate its approach to risk education.

To measure the program’s effectiveness, MAG community liaison teams normally use a tailored survey that tests comprehension of key messages among target beneficiaries. The survey is typically completed immediately before and after risk education sessions. With DFID funding, MAG monitored for the first time the change in content-retention levels over time and completed a comprehensive analysis of the results across different target groups and methodologies.

Target Groups

For the project, MAG identified three principal target groups for risk education activities and employed three different methodologies.

First target group. MAG used general presentations for the first target group consisting of up to 50 adults (women and men). These sessions lasted approximately 45 minutes and covered the principal themes of risk education: ERW identification/recognition, ERW effects and impacts, suggested behaviors, and recognition of local and international ERW markings.
Trained community liaison officers delivered the sessions in the local language using standardized banners with words and images. The participants’ ability to read or write did not affect the training. The officers encouraged audience members to participate at various points during the session, particularly during sections on behaviors (e.g., demonstrating ERW marking, informing populations, etc.). Each session included time for questions and answers.

Second target group. MAG selected groups of eight to 10 women, to participate in the second target group, which consisted of focus-group discussions to convey the content. This methodology encouraged participants to lead discussions around the principal themes of risk education. Selected images stimulated debate about key subjects. A facilitator guided the discussion, usually with a second, supporting facilitator acting as an observer. The objective was for participants to identify the problem and develop solutions. This process of analysis helps to develop key messages in beneficiaries’ minds and assists with identifying and exploring risk-reduction strategies. It also relies on strong audience participation.

Third target group. Primary age schoolchildren comprised the third target group, usually reaching around 30 participants for each session. MAG taught key messages through song and play. In this approach, images (standardized and approved by the United Nations Mine Action Coordination Centre) and games stimulated discussion about ERW effects. By using words and image banners, MAG taught children UXO- and mine-recognition basics. Role-play illustrated safe behaviors that children should adopt in the presence of ERW. The sessions were highly participatory and were kept to a maximum of 30 minutes to maintain the children’s interest.

During the course of the project, 2,506 individuals from 32 villages in Dimbelenge, a territory within DRC’s Kasai Occidental province, benefited from the risk education activities. Of these villages, half were included in the first target group and participated in the general presentation, while the other half were part of the second and third target groups. In total, 456 beneficiaries completed surveys before and immediately after risk education sessions and again one week later. The results revealed interesting patterns of understanding among the beneficiaries.

Outcomes

Immediately after the session, all groups demonstrated a notable increase in understanding. On average, before the program, beneficiaries answered only 42 percent of questions correctly. Immediately after the sessions, 82 percent of the questions were answered correctly. This suggests that all beneficiaries were interested in the messages relayed and supports the success of the various methodologies. After one week, the average number of correct answers was only reduced by 1 percent, with 81 percent correct. Further follow-up is needed to determine how long high levels of understanding are maintained.

Beneficiaries in the first target group on average demonstrated the highest levels of understanding of risk education both before and immediately after the sessions. This is most likely because these groups consisted of a higher ratio of men, who generally have more access to education in DRC than women. This methodology may also be the most well-known to MAG community educators, and hence they deliver it most effectively.

Beneficiaries in children’s groups demonstrated the lowest levels of comprehension before and immediately after the sessions, which is most likely due to factors including participant age and education level. However, these results may also suggest that MAG educators do not yet implement the children’s sessions as effectively as other methodologies and that adaptations in content delivery may be needed. Alternatively, the retention survey may need modification specifically designed for children.

Although the second target group, the women’s group, demonstrated lower levels of understanding than the first target group (consisting of men and women) before and after the sessions, the women who participated in focus group
discussions (second target group) demonstrated the greatest increase in understanding. This group answered 44 percent more questions correctly after the risk education session than before, when the average increase across all groups was 41 percent. Finally, women benefiting from focal groups also displayed the highest rate of information retention on the quizzes given one week after the risk education sessions.

These results suggest the methodology relative to the target groups was the most effective for the second target group. This suggests that the focus-group approach can effectively be used in risk education activities for women in DRC. Recognizing strategies that reach women and girls is important when working in a country like DRC, where women are far less likely to partake in community education activities carried out in a public and mixed-adult setting (as done with the general presentation methodology used in the first target group). In addition, women are frequently those most at risk from ERW’s negative effects. Women are usually most likely to enter potentially dangerous areas such as fields, wooded areas and water sources because this is where their daily activities lead them (e.g., cultivating land, collecting water and firewood, etc.). Often, women are the least educated about the potential risks of mines and UXO and are the least informed about what to do if they find an item.

The survey also analyzed the educational content that beneficiaries most and least understood. Very similar patterns emerged across all groups. Before MAG delivered the risk education, beneficiaries on average had a notably high level of understanding of mine and UXO dangers and how to recognize a potentially dangerous area in their community. However, participants did not know how to identify mines and UXO or the behaviors to adopt around them. Familiarity with mines, UXO recognition and improved behaviors around UXO increased significantly after risk education sessions. In some cases, beneficiaries still seemed unclear on how to recognize the difference between mines and UXO and the related appropriate behaviors.

While the results were not unexpected, the study provides evidence that a tailored approach to risk education is likely to yield more positive results relating to beneficiary learning and understanding. Organizations should continually monitor and assess the effectiveness of their interventions to ensure that their risk education program is effective. When done correctly, risk education positively impacts the community.

A MAG community liaison officer carries out a risk education message retention survey with a beneficiary in Dimbelenge territory, DRC.

Vicki Peaple has worked as a community liaison manager for MAG (Mines Advisory Group) in DRC since 2011. She has worked with teams delivering risk education to communities across four different provinces in DRC and is currently based in Katanga province.

Vicki Peaple
Community Liaison Manager
MAG
Democratic Republic of the Congo
Email: info@maginternational.org
vicki.peaple@magdrc.org
Tel: +243 81 593 6198
website: www.maginternational.org
Land Release in Action

As part of the EU-funded TIRAMISU project, the author conducted a comprehensive survey of land release procedures in six countries during 2012. The results show that expectations of technical survey machines should be defined and standardized through tests and evaluations.

by Emanuela Elisa Cepolina [Snail Aid – Technology for Development] 
with editorial support from Andy Smith [Mine Action Specialist]

From 2 April to 8 July 2012, Snail Aid – Technology for Development carried out a three-month survey of relevant mine action stakeholders in Angola, Bosnia and Herzegovina, Cambodia, Croatia, Northern Iraq and Tajikistan to assess best practices on land release. Recognizing a lack of published information about how land release is implemented in the field, this study records, compares and assesses land release practices in use by 14 different organizations in six countries. The results provide a detailed snapshot of current practice that serves as a foundation for further research within the EU-funded TIRAMISU project, an integrative project to develop a comprehensive toolbox for humanitarian de-mining. It is hoped that the study will lead to improvements in land release methodology. The complete study report is available on the project website: http://www.fp7-tiramisu.eu/.

The land release study’s aim was twofold: to identify and share best practices among mine action operators and to identify strengths and weaknesses in land release processes. To achieve this, the study gathered as much detailed data as possible on the two core land release components: Non-technical Survey (NTS) and Technical Survey (TS). The majority of those interviewed welcomed the study, acknowledging the need to compare practices between organizations and countries. The complete study report presents the large amount of data in a raw format as it was collected from interviewed stakeholders. The idea behind making raw data public is to provide a database suitable for further analysis and investigation. Findings other than those discussed here may be made by analyzing the data in different ways.

<table>
<thead>
<tr>
<th>Plan of visits: data to collect from each organization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day</strong></td>
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Table 1. Planned schedule of visits to organizations and data collection.

All graphics courtesy of the author.
Methodology

The mine-affected countries visited—Angola, Bosnia and Herzegovina, Cambodia, Croatia, Northern Iraq and Tajikistan—had been previously surveyed and were conducting land release procedures. Reasons for selecting one country over another included the length of time that land release was implemented and the local construction of some demining machines used in TS.

Of the 14 mine action organizations in the six countries participating in the study, not all performed both NTS and TS. As a result, the amount of data collected varied for each organization.

The study was not designed to compare efficiency in achieving land release so the organizations are not named in the study report. Particular attention is given to presenting data in a way that allows comparison between answers provided by anonymous organizations. While the full analysis regarding the tools used and questions asked during the survey are in the complete study report, Figures 1 and 2 (page 46) provide short descriptions of each.

Whenever possible, arrangements were made to visit and interview mine action organizations before the field study started. Carefully designed, structured interview and data-gathering techniques were used. The author visited multiple organizations involved in land release in each country and collected data on an ad hoc basis. The flexible data-collection methods are described in the full study report.

Non-technical Survey and Technical Survey

For NTS, the study focused on collecting indicators of mine or explosive remnants of war (ERW) absence or presence used to evaluate the probability that an area was contaminated. Particular attention was given to the criteria for (threat) cancellation based on agricultural use of the land. The author looked for direct connections between indicators and land threat classification, especially when quantitative values of indicators (such as the number of years land had been used without finding evidence of hazards) were used to make decisions affecting TS requirements. The study also documented the credibility assigned to informants, providing information about the presence of mines, the different possible outputs of NTS in terms of threat levels, and the constraints on the application of TS assets (such as vegetation and the type, depth and anticipated pattern of mine and ERW hazards).

<table>
<thead>
<tr>
<th>Country</th>
<th>Particular facts</th>
<th>Visa</th>
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<tbody>
<tr>
<td>Bosnia and Herzegovina</td>
<td>Definition of ground processing in quantitative terms, use of Advanced Intelligence Decision Support System (AI DSS) (based on airborne and space born remote sensing). Local construction of demining machines</td>
<td>No</td>
</tr>
<tr>
<td>Croatia</td>
<td>Use of airborne and space born remote sensing; local construction of demining machines</td>
<td>No</td>
</tr>
<tr>
<td>Angola</td>
<td>Local construction of demining machines; training site for mechanical demining in Cunene</td>
<td>Yes, at the embassy in Italy</td>
</tr>
<tr>
<td>Northern Iraq</td>
<td>Local construction of demining machines</td>
<td>Yes, on arrival</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>At the beginning of the process; just starting accreditation of machines</td>
<td>Yes, on arrival</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Long history in land release</td>
<td>Yes, on arrival</td>
</tr>
</tbody>
</table>

Table 2. Countries chosen for data collection and the reasons behind their selection.

![Image of Table 2](image-url)
For TS, the study focused on the critical process of assigning a level of confidence to the varied demining assets that were used to conduct TS. For each asset, the study recorded its application in relation to the type of hazard anticipated and the other constraints identified during NTS.

Generally, all NTS efforts studied were intended to:

1. Identify confirmed hazardous areas (CHA) while assigning a certain level of confidence to the statement that the area contained mines or ERW
2. Re-examine the evidence for the status of suspected hazardous areas (SHA) while assigning a level of threat or level of suspicion to the area
3. Classify SHA/CHA according to the socioeconomic impact that the hazards had on communities, thereby informing the prioritization of subsequent TS and clearance work

These generalizations conceal the fact that one organization’s NTS was only aimed at defining the socioeconomic impact of the SHA on local communities while three other organizations did not assess socioeconomic impact during NTS at all. Some organizations used more than one NTS report form, which added confusion to the process of comparing their outputs.

Findings

This study found a large gap between the theory of land release and its actual implementation. In every country, terminology varied or was used to mean different things that were rarely in accordance with the definitions used in the International Mine Action Standards. The division between general survey, impact survey, NTS and TS concepts varied from one organization to another, and the range of activities involved in the phases of survey varied according to the organization and the country of operation.

The biggest difference between the NTS practices used by the organizations visited was in the way that the NTS outputs affected the conduct of subsequent TS. Only two organizations changed their approach to TS as a result of the output of NTS. In one organization, the size of the area that must be investigated during TS was reduced as the level of risk assigned to the area after NTS decreased. In the other organization, the size of the area investigated was reduced as their level of confidence in the asset used to conduct TS increased.

It is significant that none of the organizations visited had established a system for evaluating the varied performance of the assets they used to conduct TS. Although one reduced the area searched according to their confidence in that asset, no system for assessing and comparing the level of confidence or reliability of the assets and the procedures in which they were used was in place. Despite one organization using a written standard operating procedure that allowed the search of a smaller area when a “reliable asset” was used, no system was in place for defining what was “reliable” or deciding what level of follow up behind the varied TS assets would consti-
JOURNAL: The Journal of ERW and Mine Action Issue 17.2

One organization appeared to prefer using a mechanical asset over the entire SHA/CHA during TS. For that organization, TS only differed from clearance because it allowed the use of a less efficient asset over the entire area. All other organizations generally used TS assets over a proportion of the area. When it did not depend on the level of threat assigned to the area during NTS, the criteria for determining the size of the area processed during TS varied according to the organization. In one case it depended on the number of assets used to process the area. In another case, it depended on the ability to perform visual inspection after the asset had been used. In yet another case, it depended on the residual threat when all hazards expected to be present had not been found.

The use of land was recorded in the evaluation of the land’s hazardous status in a way that varied greatly from one organization to another. Of the seven organizations asked about NTS, all except one made the length of time that the land had been in use a parameter in their definition of the significance of land use. Of these, only three organizations also considered the depth of soil disturbance during land use and only one took note of whether the land had been cultivated manually or mechanically.

The assets used during TS also varied. All organizations used manual deminers. Six of the seven also used machines. Four used a combination of manual deminers, machines and dogs. Among the six organizations using machines, one used four different types, two used three types, one used two types and two only had access to one type of machine. Among the different types of machines used, small flails were used by two organizations, medi-
um tillers by two organizations, and a medium flail by one. Large flails, large tillers and large excavator-based flails were used by a single organization. Two organizations used mine protected vehicles and two used armored front loaders. One used sifters and one used brush cutters. Although traditional demining machines such as flails and tillers are most used during TS, they may not be the most appropriate because they are intended to detonate mines. TS is intended to collect information about contamination and this is best done by using assets that detect and identify the devices and their precise locations rather than detonating some of them in the ground. All organizations studied used their machines with some kind of follow-up, so the use of flails or tillers that detonate, deflagrate or disperse hazards was less than ideal. When asked what was the best condition in which to find mines after a machine had been used to process an area over which there would be manual follow-up, stakeholders confirmed that it was better if mines were left intact. When mines were touched, it was better if they had not been crushed or initiated. One organization clearly stated that machines were not deployed with the aim of detonating mines but were only used to cut vegetation and loosen the soil.

All organizations except one agreed that it was possible to use ground-processing tools similar to those used by farmers in TS. This was suggested because areas that have been mechanically cultivated using farm implements for a defined period of time without any indication of the presence of mines are frequently released during NTS.

During the study, the organizations using machines had a high level of confidence about the kind of hazard in the area subjected to TS. Field evidence showed that, for TS, no machine was expected to detonate or crush all mines or ERW. All except one of the machines in use could not be deployed in areas where there might be mines containing more than 2 kg (4.4 lb) of TNT. This suggests that agricultural machines used in TS would only need to be modified to withstand the detonation of small mines.

The study also examined what soil-processing output was expected of machines used in TS. The organizations reported a depth of processing between 10 cm (3.94 in) and 30 cm (5.12 in). Only one organization defined the type of soil processing with reference to the maximum size of soil particles that could be left behind the machine.

Conclusions

One of the study’s most important findings is that no common standard is in place for the use of machines during TS. There is no agreed way to determine the level of confidence that results from the use of machines, and opinion about this varies considerably. Machines used during TS need not be designed to detonate mines, so the existing mechanical CEN Workshop Agreement for evaluating machines is not applicable.³

An immediate need exists for a well-defined, systematic definition of what is expected from TS machines. Confi-
Major facts about land release practices:
~ Scheme summarizing NTS and TS input/output, procedure, and technology
~ Written description

Charts display answers to key questions on requirements for mechanical assets

Figure 3. Presentation of data.

Figure 4. Operational aspects investigated when choosing a machine for TS. Data from five questionnaires. For two categories, the response was 0.
Emanuela Elisa Cepolina, Ph.D., is a mechanical engineer with 10 years of experience researching sustainable and appropriate technologies for humanitarian demining. During her research work she visited many mine action activities in 12 countries and acquired a deep understanding of the mine action environment and challenges. She recently worked on the design, development and in-field test of Locostra, a low-cost machine built around a small agricultural tractor. She has worked at the University of Genova (Italy) and is the president of Snail Aid – Technology for Development, a not-for-profit social enterprise. Since January 2012, she has worked on the EU-funded TIRAMISU project.

Acknowledgements: The European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 284747 funded the research that led to the information and results. The author would like to thank all the people who made this study possible by spending their precious time with her, for their patience in answering her questions, for the interesting discussions that took place during and after work, and for all that she has learned. It is an incredible privilege to be able to visit mine-affected countries with the support of experienced people who work there. This support allowed her to gain a deeper understanding of their country’s history and problems inside and outside mine action. She also thanks her friend Andy Smith for providing helpful editorial input and encouragement.

TS being conducted on a steep slope in Iraqi Kurdistan, where demining machinery able operate on such terrain is currently unavailable to the organization.
A Stand-off Seismo-acoustic Method for Humanitarian Demining

Using seismo-acoustics to detect landmines may be an efficient and cost-effective demining method. It may also work in wet soils and allow discrimination between mines and metallic clutter. Bechtel, as a junior in high school, was a finalist in the 2012 Intel Talent Search for her research on seismo-acoustic detection and was invited to present at the second annual U.S. White House Science Fair.

by Marian Bechtel

In humanitarian demining, the most common detection methods are manual approaches that can be tedious, time-consuming and dangerous. One of the issues posed by current demining technology includes metal detectors, although an important tool because of their low cost and simplicity, cannot detect minimum metal (plastic) mines. Many methods, including metal detectors, probing spikes, etc., also cannot discriminate between landmines and clutter, such as rocks, scrap metal and shrapnel. This results in false-alarm rates sometimes higher than 90%, causing scarce demining funds to be spent largely on trash collection. Another obstacle is that most electrical and electromagnetic methods are useless when the ground is wet.

Research is being conducted worldwide to find more efficient methods for demining. However, many new technologies are expensive and complicated, making them impractical in poor, war-torn countries. In addition, as Colin King, editor of Jane’s Mines and Mine Clearance, stated: “... some of the demining agencies, having been disillusioned by a stream of ill-conceived ideas, will hardly consider the possibility that new technologies could help them.”

Seismo-acoustic Detection

This study investigated the use of seismo-acoustics in the form of a continuous-wave seismic transmitter (or shaker) to induce vibrations in the earth, which may be amplified by elastically compliant buried mines. Microphone receivers record the coupled acoustic vibrations in the air above them. Noise cancellation is applied to enhance signal-to-noise ratio and create a characteristic sound pattern that allows pinpointing of mine locations. This method is inexpensive, involves no contact with the mine-contaminated ground and has the potential to work well in wet soils—a distinct advantage over ground penetrating radar (GPR), the other common method for detecting non-metal buried targets.

The ability to detect landmines with seismo-acoustics is based on resonance between the shaker and elastically compliant targets. Landmines are elastically compliant containers that, when excited by seismic waves with frequency content spanning their natural period, will resonate and cause vibrations in the soil and air above them. In contrast, many clutter objects (e.g., rocks, bricks, shrapnel) are not compliant and will not resonate like mines. This allows for discrimination between landmines and clutter when using seismo-acoustics and could greatly lower the false-alarm rate in demining. The fundamentals behind this process are similar to those in methods that use laser Doppler vibrometers. However, using an acoustic receiver rather than a seismic one could help overcome the issue of heavy vegetation, which can be a limiting factor in the efficiency of laser Doppler vibrometers.

This study follows two previous years of research on seismo-acoustic mine detection. The first year was spent on proof-of-concept testing to see whether mines could be made to resonate, and the results suggested that not only is seismo-acoustic detection possible, but discrimination between landmines and clutter may be possible as non-compliant rocks and steel scrap did not resonate. The second year tested the potential for the creation of acoustic images based on gridded vibration measurements, with each grid cell representing an image pixel. Both of these early studies relied on seismo-acoustic coupling using an acoustic transmitter and seismic receivers. Although this was effective as a scientific exercise and demonstrated that mines could be made to resonate, it would be impractical in the field due to the expense of seismic sensors, the need for direct (and dangerous) ground contact, and the impracticality (and inconvenience) of mobilizing and operating a powerful acoustic source above a minefield. However, these investigations provided the foundation for another year of work to design a practical, cheap and stand-off (non-contact) seismo-acoustic device that could be developed for field use.

Testing the concept of a seismic source exciting resonance in a mine, which could then be detected by recording the coupled acoustic field above the mine, was broken down into three phases.

Phase I Testing

Phase I focused on confirming that a noise-cancelling microphone system could detect the sound of an object resonating below the level of ambient noise and locate it based on the spatially variable acoustic field.

To create the microphone receiver system, two high sensitivity, broadband microphones (loaned by Earthworks) were set at a fixed separation on a hand-held bar (a broom handle). The microphones were connected to a Mackie Onyx Blackjack two-channel amplifier and
analog-to-digital converter with a USB connection to a laptop running GoldWave digital audio editing software. 8

To simulate the “sound” of a buried, resonating mine, a small speaker was placed beneath a thick, folded blanket on the lab floor. Computer-simulated tuba notes were played through the speaker at sound levels well below ambient noise levels. The tuba notes were rich in low frequencies intended to match the resonant frequencies of anti-personnel (AP) mines. Ambient noise was created by running a drill press and other lab tools.

The microphone system was swept over the hidden speaker (or lack thereof in control tests) to record the simulated sound of a resonating buried mine. Noise cancellation was performed manually in GoldWave (see Data Analysis).

Phase II Testing
Following analysis of the Phase I data, which confirmed the ability of the microphone system to detect and pinpoint the location of resonating objects, the next step was to test whether a ground-coupled seismic source could cause a mine to resonate.

A concrete vibrator (the seismic shaker) was placed in one corner of a 3.05 m x 3.05 m (10 ft x 10 ft) sand test bed. On the opposite side, three geophones (Oyo 100 Hz natural frequency) were placed on top of the sand using flat steel snow plates instead of typical geophone spikes. Buried beneath one of the geophones was a mock mine, while the others rested on uniform sand. The mock mines were cylindrical metal and plastic mint containers filled with RTV silicone rubber, which simulated the dimensions and physical properties of AP mines. 9 With the vibrator running, the geophones recorded the vibrations of the material beneath them onto a Geometrics StrataView digital seismograph. Even before spectral analysis of the geophone records, it was clear simply by looking at the seismic wiggle traces that the two geophone recordings over featureless sand were nearly identical, while the one over the mine was different.

Phase III Testing
Combining the first two phases (testing of receiver and source respectively), the microphone system was taken to the outdoor sand test bed. In the next set of tests, the microphone system was swept along a test strip in the sand, beneath which a mine was buried at the midpoint (see Figures 1 and 2). Control tests with no target and tests with buried plastic and metal mine simulants were completed with the microphones about 5 to 10 cm (1.97 to 3.94 in) above the ground. Test results of this distance from the ground determined it to be the optimum sensor height. 10 For all of these outdoor tests, the test bed was near a major road, so background noise was substantial and non-systematic.

An important goal of this project was to test mine detection in soils with high moisture content. Therefore, tests were run in matching sets in which a metal or plastic mine was buried. Detection was done with dry sand and then with thoroughly wetted sand.

For all tests, the exact time that the two microphones were centered over the buried mine was recorded. This was critical since the microphones were swept by hand with consequently variable speed.

Data Analysis
First, the geophone recordings from the Phase II tests were Fourier-transformed from raw time domain wiggle traces to frequency domain vibration spectra. Correlation coefficients were calculated between spectra for multiple geophone-over-sand (no mine) records and for geophone-over-sand to geophone-over-mine (mine) spectra. For all tests, the correlation coefficient for no-mine/no-mine spectra was significantly higher than any mine/no-mine pairings. This spectral analysis quantified the apparent visual difference between the wiggle trace records for ground vibrations above mine and no-mine conditions.

To analyze the microphone data for the Phase I testing over a mock mine sound source and Phase III testing over resonating mines (excited by the shaker), the critical component was noise cancellation. This was necessary because the sound level of the vibrating mine was much
lower than ambient noise. For the microphone testing, the sound from each microphone was recorded on a separate track in a stereo sound file so the recordings would be separate but perfectly synchronized (Figure 3). Initially, the sound from the matched microphones was recorded with the same polarity, and one track (one microphone) was inverted and added to the other track, creating a single, digitally noise-cancelled recording (Figure 4).

This noise cancellation produced a visible and audible swell-null-swell pattern in the waveform. This pattern was presumably due to the microphones recording identical waveforms for remote-source ambient sounds, differing waveforms when one microphone was close to the resonating mine, and identical sounds when the microphones were exactly equidistant (spanning) the resonating mine. The sound swells as each microphone passes over the mine, but when centered over the mine, the combined signal cancels. This null did not appear in the noise-cancelled waveforms of control tests, where no mine was buried.

Of course this visual and audible difference is exactly the sort of simple and real-time result that a device should produce for a deminer in the field. But as a scientific matter, it was important to evaluate the significance of the apparent difference in the mine versus no-mine sound records. In order to get statistical results that support the visual/audible evidence, a mathematical model of the noise-cancelled waveforms was developed.

The noise-cancelled waveform files were saved as ASCII text files and opened in Microsoft Excel. The time-series sound-level samples for each test were squared to produce a sound-power time series then de-spiked with a very narrow, low-pass filter, which removed values that exceeded the average over a five-sample rolling window, to remove transient outliers or pops in the sound. The overall shape of the sound-power time series (or sound envelope) was calculated for each record by applying a wide, low-pass filter, which included maximum power values over 300-sample rolling intervals. By examining these sound envelopes, the minimum of the sound power clearly indicated the location of a mine.

These test envelopes were next compared to a theoretical envelope, modeling the expected results when the two microphones passed over the resonating buried landmine. This theoretical envelope was created mathematically by multiplying the formulas for sound attenuation due to geometric spreading and material loss. Test envelopes were compared to this theoretical envelope, and a root mean square (RMS) residual value was calculated to represent how well the test matched the model. In the model formula, variables (attenuation coefficient in air, microphone height, sweep velocity, etc.) were adjusted to provide a best-fit between the model and each record. To minimize the model-test RMS residual, this was done with an iterative Monte Carlo inversion (Figures 5 and 6).

The theoretical envelopes were then compared to several control test envelopes, in which no mines had been buried, and an RMS value was found for each. Looking at the raw numbers, the control (no-mine) RMS values appeared to be significantly higher than the target (mine) RMS values (Figure 7). To confirm the significance of this difference, Dixon’s Q-test for outlier detection was used to determine whether the RMS residuals for the control (no-mine) tests were in fact statistically and significantly different from the target (mine) RMS values—in other words, to test whether the control RMS values were outliers in the full set of RMS data values. The results of this statistical test showed that, at a 99% confidence level, the control RMS values were outliers and were incredibly unlikely (p=0.01) to be produced in this data set simply by random chance. These statistics provided overwhelming evidence that there was a statistically significant difference between sound recordings for mine versus no-mine noise-cancelled sound records.

Discussion and Conclusions

The goal of this study was to demonstrate the feasibility of a seismo-acoustic system that used a shaker to make buried mines resonate and a dual microphone noise-cancelling sensing system to pick up the sound of the resonating mine and pinpoint its location. This goal was met in an observational as well as statistical sense.

One of the most significant findings was that the method worked for both metal and plastic mines buried in wet sand (Figure 5). Currently, the only efficient method for detecting plastic mines in wet soil is direct, intrusive probing with a sapper spike. This is because moisture raises the electrical conductivity of soils, making them highly lossy for electromagnetic signals (e.g., GPR). Seismo-acoustics, however, rely on mechanical properties, and moisture will not affect the ability to detect mines, metal or plastic. In some cases, moisture in the ground could actually improve results simply because water is a low attenuation material for seismic and acoustic waves.
Another significant benefit to this method was safety and simplicity. The microphones were not in contact with the ground, which minimizes the danger of setting off a mine. Moreover, the actual tests were simple, quick and produced real-time results (when the microphones were wired to do real-time noise cancellation in the prototype described below). The simplicity of the method is a key factor in applying it in the real world. Many deminers have little advanced technical training and deserve a device that does not require special expertise. As Colin King put it, "All they want is a beep." 4

This method could also reduce false-alarm rates relative to metal detectors or even radar as elastically noncompliant clutter items in a minefield will not resonate with the seismic source, and thus would not be detected. Also, the noise-cancellation system provides its own reference or site-specific tuning: It is constantly adjusting to the background signal for no mine in a new location with new soil and/or ambient noise conditions. These results suggest that seismo-acoustic detection is not only possible, but could be a very effective, simple and relatively cheap humanitarian demining method.

Building a Prototype

Based on the proof-of-concept results described above, a prototype detection device was built using inexpensive, off-the-shelf and recycled or repurposed materials. The total cost was less than US$500. The skeleton of the device was an old metal detector rescued from a dumpster. Attached to the bottom at a fixed horizontal separation, as in the original tests, were two microphones similar to the ones used in testing phases but significantly cheaper and of lower quality. The microphones were connected to a small two-channel amplifier affixed to the bracket where the metal detector controls were, with a set of noise-cancelling headphones connected to the amplifier (Figure 8).

The signal from the microphones was fed through two identical phase inverters into the amplifier; one was set to invert the sound 0°, the other to 180°. The two signals were summed in analog by passing through a stereo-to-mono converter plugged into the headphone slot as the summed signal fed into the headphones. The device conducted analog noise-cancellation in real time and fed it directly into the headphones so the user could listen for the swell-null-swell pattern.

Some field tests were done with this prototype in the outdoor test bed with inert landmines, including a small AP landmine (Chinese type 72), as well as a larger anti-tank mine (Italian 85S-9). The results for this first prototype were very promising. When the device was swept above a buried landmine, it was possible to hear the characteristic swell-null-swell pattern—even without being associated with the research and not having been previously instructed in what to listen for. Obviously there is still much research, testing and improvement to be done, but tests with this simple prototype show great potential for the eventual development of an effective detection device.

An Addition to the Toolbox

Although this research produced exciting and promising results, it is important to note that seismo-acoustics is not, and probably will not be, the ultimate solution to landmine detection. It is an additional tool in the mine action toolbox that can complement other methods such as metal detectors, but it is not a replacement. This method should be seen as an addition to the toolbox, rather than a replacement for current technologies.

Figure 5. Model sound envelope compared to observed sound power data for a plastic mine buried in wet sand.

Figure 6. Model sound envelope compared to observed sound power data for a metal mine buried in dry sand.
never be, a perfect demining tool. It does, however, have certain unique advantages, namely that it can effectively detect plastic mines in wet environments, that could give it a specific and important niche in the ever-developing landmine detection toolbox.

See endnotes page 66

The author would like to thank Lorenzo Capineri of the University of Florence and Sean Sennott, Vice President of FDW Corporation, for their advice and support, as well as Earthworks, Inc. and Enviroscan, Inc. for use of their equipment. A final thanks goes out to the Salamanders, a group of the author’s friends who assisted with the review of her paper.

Marian Bechtel is a rising sophomore at Bryn Mawr College in Pennsylvania, where she is studying physics and geology. She was named a 2011 Davidson Fellow and chosen as a finalist for the 2012 Intel Science Talent Search. She also participated in the Royal Society of London’s 250th Summer Science Exhibition as a member of the RASCAN Group research team.

Marian Bechtel
Bryn Mawr College
Tel: +001 717 824 2614
Email: mbechtel@brynmawr.edu

Figure 7. Histogram of model versus data RMS residual values for target (mine) and control (no mine) tests. Note the lack of overlap between target and control value ranges.

Figure 8. Photo of the prototype.
Analyzing Functionality of Landmines and Clearance Depth as a Tool to Define Clearance Methodology

Mine contamination from World War II remains in Skallingen on Denmark’s western coast. Skallingen’s dynamic coastal environment caused the mines to shift in the soil, and time, salt water and soil depth rendered some of the landmines inactive. Comparative digital-terrain models, in addition to surveys and analysis of fuze and detonator functionality, enabled clearance personnel to establish clearance depth and related criteria and facilitated efficient clearance efforts. As a result, the last functional mines were cleared in June 2012 after six years of effort.

by Martin Jebens [Danish Coastal Authority]

During World War II (1939–1945), German forces placed approximately 1.4 million landmines along the Danish west coast as part of the West Atlantic Wall. After the war, manual clearance and the use of tanks with rollers operated by former German soldiers under Danish and British command removed the majority of these mines. While the boundary of each minefield was known in the area of Skallingen, the mines were randomly placed within each minefield. Thus, total clearance of the area and the remaining 72,000 mines was impossible.

During the next 65 years, dynamic changes in the environment, including erosion, moved or rendered many of the mines inoperable, changing their depth and condition. In 1999, Denmark signed the Convention on the prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction (Anti-personnel Mine Ban Convention or APMBC). Clearance of the anticipated 10,000 remaining mines began in 2006. Since then, clearance has been carried out in three phases; the last phase ended in June 2012.

During and after the first two phases, a number of Technical and Non-technical Surveys (TS, NTS) were completed to further determine the characteristics of the minefields. In particular, the current depth and condition of remaining mines were investigated. These investigations showed that Skallingen mines in contact with salt water for more than three years do not work as originally intended. This is due to the alteration of explosives in the detonators and the corrosion of metal in the fuzes. A three-dimensional (3-D) digital-terrain model of the 1945 surface also determined the recommended clearance depth to avoid clearance of unnecessary quantities of soil.

These relatively inexpensive analyses at Skallingen resulted in the use of different clearance techniques to target each specific threat in the different geomorphologic terrain types. With the resulting information, the clearance operation was accomplished in a shorter time and at a lower cost. Clearance was also more environmentally friendly, for example, avoiding damage to sensitive marsh and beach areas by preventing unnecessary heavy machinery from entering the areas. Similar analysis of mines and soil composition in other mined areas could result in a more flexible approach to the clearance work and may reduce cost and risk.

Environment and Dynamic Processes

Due to its geomorphology, Skallingen has a unique fauna, flora and landscape. The marshlands on the peninsula’s eastern part represent the largest unprotected salt marsh in northern Europe. Likewise, the dunes and beaches on the western and southern part of the peninsula are nearly undisturbed by man. The peninsula extends approximately 12 km in a southeasterly direction with a width of about 2.5 km.

Placed in a dynamic coastal environment, the minefield is influenced by a number of physical processes on a daily basis, including erosion caused by wind and water, dune migration, marsh build-up and marsh and dune expansion.

The beach zone (Figure 1) is a deposit of unconsolidated sand sediment that is easily influenced by aeolian (wind) and hydrodynamic (water) processes caused by the strong westerly winds from the North Sea. This results in surface changes and the rework of sediment, which can exceed 1 m a day.

The beach is backed by a dune zone (Figure 1), an accumulation of sand built only by aeolian processes. Dunes are entirely composed of unconsolidated sediment and tend to be fragile, mobile and susceptible to erosion until they become vegetated, which stabilizes them. As a result, dunes can easily change shape and move into the marsh area over time. Dune elevations of up to 10–12 m are fairly common on the peninsula.
Behind the dunes is a region of marsh and tidal flats (Figure 1) where the quiet waters allow fine silt and clay to settle to the bottom of the water. Because of the low energy environment, erosion does not occur. Tides influence the area daily, resulting in waterlogged soils and standing water. The tide has an amplitude of 1.5 m, but in combination with stormy conditions, the tide can exceed 4 m.

Changes in Terrain

From the geomorphology described above, it is evident that the dynamic character of the area changes its topography. As a consequence, mines may be buried deeper by sediment build-up or exposed by erosion. Because of these changes, the expected clearance depth prior to the start of clearance was unknown, and operating with standard clearance depths was impossible. Therefore, to target the mine-affected surface, a digital-terrain model of the surface from 1945, when the mines were laid, was made.

In its simplest form, a digital-terrain model consists of millions of x, y and z values, where x and y are the geographical coordinates and z is the elevation. A digital-terrain model can be acquired in a number of ways: by digitizing topographic contours from paper-based maps, photogrammetric analysis of stereoscopic aerial photos, or by airborne radar or laser scanners.

Producing a digital-terrain model of a historic surface requires old aerial photographs, which have a limited use in a geographic information system (GIS) because they are not true to scale. However, if the aerial photo is geometrically corrected for distortion caused by the topography, camera optics and camera tilt, it is possible to make a digital orthophoto or a digital-terrain model. The orthophoto becomes a photo map on which direct measurements of distances, areas and positions can be made.

Aerial photos were (and continue to be) taken during a large number of conflicts worldwide. British archives hold more than 40 million aerial photos taken during WWII. During the war, the British Royal Air Force passed over Skallingen several times, and photos taken during these missions generated the digital-terrain model.

The terrain model was created in cooperation with the Danish Consultancy within Engineering, Environmental Science and Economics (also known as COWI after the initials of its founders, Christian Ostenfeld and Wriborg Jonson) using the data software SocetSet5.
The horizontal uncertainty (x,y) of the model was found to be +/- 15 cm, whereas the vertical (z) uncertainty was +/- 60 cm. The correlation of x, y and z coordinates in the model with the same positions and height in the present terrain confirmed the uncertainties (Figure 2). This correlation revealed that the uncertainty of +/- 60 cm was mainly observed in dune areas where variation in topography is pronounced. Alternatively, the uncertainty of the model in flat marsh area was approximately +/- 10 cm.

By comparing the 1945 model with a laser scan of the present surface, a differential model could be created showing the difference between the present surface and the 1945 surface, thus determining required clearance depth (Figure 2). Because of the uncertainty in the model, it was only possible to confine clearance to a hazard layer (a layer of soil that may be contaminated to a certain width and a changing maximum depth), not a surface. The uncertainty of the new laser scan of the present surface was +/-10 cm.

Adding up the uncertainties gave rise to a hazard layer having a width of 1.4 meters. Finally, the width was extended due to the fact that a stock mine could stand 30 centimeters above the 1945 surface and that mines could be buried up to 20 centimeters below the surface in 1945. Therefore, the total depth of the hazard layer was 1.9 m (Figure 3).

Changes in Dune Areas

Since dunes are made of sand, the dunes do not generally exhibit any geologically recognizable features (e.g., clay layers, cross-bedding) that can be correlated with time. Therefore, the differential model was especially useful in the dune area.

The differential model, in earlier phases of clearance, showed that the hazard layer had a 1.9-m width, ranging between 0 and 10 m below the present surface. Thus, large volumes of sand could be excavated before mine clearance began (Figure 3).

In the final phase of clearance, the model showed that the mines in the dunes were placed in a hazard layer situated between the current surface and a depth of 2 m (Table 1).

When analyzing the differential model together with aerial photos from 1945, it became clear that the southern part of the dune area had migrated across the surface of the marsh and the two had merged. This entire dune was mine-free and could be excavated before mine clearance commenced. Therefore, the dune area was further divided, giving rise...
to a new sub-area named marsh covered with dune (Table 1 and Figure 4).

Since mines were buried in the flat marsh area, the uncertainty of the digital-terrain model was confined to approximately +/- 10 cm. Thus, the risk layer was more limited in this area than to the rest of the dune area.

**Marsh**

The marsh’s vertical growth is limited because of the very low sediment (clay and silt) accumulation rate. In general, the salt marsh on the west coast experiences accumulation of 2–3 mm a year. The total accumulation since 1945 is therefore between 13 and 19.5 cm. The differential model and a survey investigating the thickness of the top clay layer confirmed this. Finally, a TS conducted in 2008 affirmed that mines could be found only in the first 20 cm.

**Beach**

When mines were laid in 1945, the area presently defined as a beach was a marsh. During the last 30 years, the coastline retreated at the southern part of Skallingen, eroding the marsh and leaving behind sand. As a consequence, the only mines found in the beach area were mines that the dunes ejected onto the beach via erosion. On the beach, the locations of the mines effectively depended on the constant transformation of sediment.
personnel (AP) mines. Except the Tellermine (metal casing) and Schütz (wood casing) anti-mines (wood casing), as well as Stock (concrete casing) and Holzmine 42 anti-tank (AT) mines. On the beach, the mines will work if they have recently been uncovered from the dunes. However, once on the beach the mines quickly decompose or break apart due to wave action.

Table 4. The functionality of different mines in various environments on Skallingen. The chance of all components in the explosive train to work in individual mines in these conditions is very limited. The fuze and detonator in the Tellermine 42 is encapsulated behind a metal casing. Therefore, water needs time to enter the explosives inside the detonators, and the mine may still function. There is a small risk that the mines will work on the beach if they have recently been uncovered from the dunes. However, once on the beach the mines quickly decompose or break apart due to wave action.

Functionality
During clearance, analysis of the present quality and functionality of the mines was conducted, concluding that the quality and functionality depends on the mine type and environmental conditions. A mine’s functionality is understood as the mine’s ability to function as intended. Namely, if an external action can detonate a mine, occurring under normal activities at Skallingen, it is considered functional. The following is a short review on how the functionality of mines was established using chemical and mechanical techniques.

Mine types. The only mines found in the area on Skallingen were Tellermine 42 (metal casing) and Holzmine 42 anti-tank (AT) mines (wood casing), as well as Stock (concrete casing) and Schütz (wood casing) anti-personnel (AP) mines. Except the Tellermine 42, each mine used a Z.Z.42 fuze. Therefore, the functionality of Z.Z.42 fuzes and detonators received special attention.

Fuzes. The Z.Z.42 fuze is a mechanical fuze produced in Germany during WWII and was the standard fuze in a number of German mines. A large number of Z.Z.42 fuzes were mechanically tested. The fuzes were normally corroded at the top of the firing pin, preventing them from moving freely. Further, the bakelite casing did not completely seal off the vital parts inside the fuzes. In the majority of Z.Z.42 fuzes, the oil, sand and rust had mixed together to create a hard plug between the hammer and the percussion cap. This obstruction dramatically lowered the chance of the hammer striking the percussion cap, rendering the Z.Z.42 fuze ineffectual (Figure 5). The functional detonators would ignite from the generated flame. The test showed that approximately 20% of the detonators found in the dunes and marsh above DVR90 were functional, while all detonators from the marsh below DVR90 were not (Table 2).

Detonators and explosives. With assistance from the Netherlands Organization for Applied Scientific Research (Nederlandse Organisatie voor Toegespast Natuurwetenschappelijk Onderzoek or TNO), the composition of explosives was tested in 48 detonators and nine percussion caps. All detonators were made of alumina (aluminum oxide). Primary explosives in the detonators were identified as lead azide and tetryl (Table 2). In all detonators, parts of the explosives were altered to different nonexplosive products (lead carbonate hydrate and/or lead oxide), but in many cases the degradation was pronounced (Table 2). Notably, a few detonators were empty.

Percussion caps also were analyzed regarding their functionality and chemical composition of explosives. According to these tests, no percussion cap worked when found in the marsh below 1.9 m (Danish Vertical Reference 90 [DVR90] or sea level).

To establish their detonability, the detonators were tested mechanically, which was done by conducting a functionality test of 28 detonators. The detonator functionality test was performed at TNO by placing a squib in the open side of the detonators (Table 3). The functional detonators would ignite from the generated flame. The test showed that approximately 20% of the detonators found in the dunes and marsh above DVR90 were functional, while all detonators from the marsh below DVR90 were not (Table 3).

### Table 4. The functionality of different mines in various environments on Skallingen.

<table>
<thead>
<tr>
<th>Sub-area</th>
<th>Minimum Clearance Requirement</th>
<th>Depth</th>
<th>Method to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dike/Dune</td>
<td>All explosive items which are larger or the same size as a detonator mounted on a Z.Z.42 fuze</td>
<td>Hazard layer between 0-200 cm below surface</td>
<td>Sifting</td>
</tr>
<tr>
<td>Marshland covered with dune</td>
<td>All explosive items which are larger or the same size as a detonator mounted on a Z.Z.42 fuze</td>
<td>Hazard layer of 70 cm situated around the original mined marsh surface</td>
<td>Sifting</td>
</tr>
<tr>
<td>Low marsh</td>
<td>All Tellermine 42 mines</td>
<td>Depth: 0-50 cm below surface</td>
<td>Metal detection with GPS positioning and data-logging</td>
</tr>
<tr>
<td>High marsh</td>
<td>All explosive items which are larger or the same size as a detonator mounted on a Z.Z.42 fuze</td>
<td>Depth: 0-20 cm below surface</td>
<td>Metal detection with GPS positioning and data-logging</td>
</tr>
<tr>
<td>Beach</td>
<td>All Tellermine 42 mines</td>
<td>Depth: 0-130 cm below surface</td>
<td>Metal detection with GPS positioning and data-logging</td>
</tr>
</tbody>
</table>

### Table 5. The sub-areas defined on Skallingen compared to minimum clearance requirement, depth and clearance method to be used. In the low marsh, the clearance depth was changed to the differential model (see Table 1) because of the potentially larger depth AT mines could be buried.

Figure 5. Schematic illustration of the Z.Z.42 fuze. The dimension is approximately 1.2 x 8.5 cm. Notice the position of the plug, which is composed of a mixture of sand grains, oil and rust.
The analysis above led to the conclusion that no percussion caps or detonators worked as intended in marsh areas lower than DVR90, and that Z.Z.42 fuzes decompose and become inactive when in contact with water, wet soils and dust. Additionally, lead azide, the primary explosive used in all detonators, will dissolve and react with salt in ocean water, creating different nonexplosive alteration products. In this case, the lead azide will likely completely alter or dissolve after three years of contact with salt water.

Because explosives used in the detonators on Skallingen react and decompose after three years of contact with water, an analysis of water levels on Skallingen during the last 65 years was conducted. Based on water-level data measured during the last 50 years, the analysis showed that marsh areas below 2.0m DVR90 would have been in contact with water for more than three years and therefore the mines were nonfunctioning. This was supported further by the fact that no detonators or percussion caps in the marsh area were functional when found lower than 1.9m DVR90.

Using this information, the marsh was further subdivided (Figure 6) into low marsh, which was lower than 1.9m DVR90 in the present terrain, and high marsh, which was above 1.9m DVR90. Each had different minimum-clearance criteria and clearance depth.

Clearance Criteria

By knowing the mines’ depth and functionality, the area could be divided into five different sub-areas while targeting the specific threat inside each area (Table 4 and Figure 6). This also enabled the employment of environmentally friendly clearance methods that were quicker and cheaper than if the clearance depth and functionality was unknown.

In the dune and marsh areas covered with dunes, sifting was the chosen clearance method due to the large volume of sand that needed clearing from the mines (approximately 420,000 sq m). A differential global-positioning system (DGPS), in which the clearance depth was recorded, guided the excavators and sifters. Furthermore, the machinery continuously data-logged their respective positions. Therefore, the depth was known at all times and saved for later quality control (Table 4). After clearance work, the digital-terrain model of the present surface was used to rebuild the area.

According to the findings from the functionality and depth analyses, it was possible to move freely on the beach and low marsh surfaces. In those areas, the Förster magnetometer, which was attached to a DGPS system, recorded the clearance method, making it possible to ensure that the entire surface was covered. Potential mines were found by processing data and selected anomalies with the same size and magnetic strength as defined by capacity tests (Table 4).

In the high marsh, manual mine clearance was conducted. This method was ideal due to the size of the minimum-clearance criteria and the expected depth (Table 4).

In total, approximately $50,000 was spent on this research. Use of the 1945 digital terrain model cost approximately $20,000, and the research on the functionality of mines cost approximately $30,000. This research may have saved the entire project up to $1.7 million because it was able to define the clearance depth and thus reduce unnecessary clearance efforts. The heavy machinery used for the DGPS system may have increased the total contract sum slightly.

Future Potential and Conclusion

Overall, this review describes a flexible response to mine clearance operations in which survey procedures play a crucial role in establishing the minimum-clearance requirement and clearance depth. Skallingen is not a geomorphologically unique area. Shifting sand dunes are found worldwide in coastal and desert areas. Coastal and delta areas also have comparable marshland globally. As in Skallingen, in similar environments the use of geomorphologic and terrain analysis can increase the efficiency and improve the results of clearance operations.

The two approaches—analyzing clearance depth and mine functionality—used here are, in combination, excellent tools in areas where
mines were buried deeper or relocated since the time of placement. Moreover, the two approaches can be used individually. In general, using old aerial photos in mine clearance operations has benefits. In arid areas or areas subject to large degrees of sand drifting, like Skallingen, a digital-terrain model of the surface at the time the mines were buried makes clearance safer, more efficient and less expensive since the clearance depth will be known. In minefields placed in open areas, old aerial photos and orthophotos could help define the minefield perimeter.

Analyzing mine functionality and quality could be important in all minefields depending on age and environment. Most environments appear to affect the functionality of mines. Only functionality of mines in the low marsh areas is described in more detail in this paper. The chance of all components in the explosive train to work in individual mines in Skallingen is very limited because of aging and the environmental conditions.

Leaving explosives behind after clearance should only be done with great care and only after conducting a detailed investigation of functionality, terrain and future land use. Ideally, this should also be done in cooperation with international clearance advisors (e.g., the Geneva International Centre for Humanitarian Demining and the United Nations Mine Action Service). Through chemical and physical investigations, we have inferred and proven that the mines in the low marsh on Skallingen do not work as originally intended. Although the area is part of a national park where the public will not likely come into contact with the remains, these explosives could still pollute the area through passive decomposition. Over time explosives will slowly dissolve and evaporate, releasing chemicals into the environment. Prior to and at the end of the clearance operation, therefore, the soils in the Skallingen areas were analyzed to identify potential pollutants. No traces of explosives were found.

Finally, the erosion of mine-contaminated areas can spread into areas that were previously mine-free. In Skallingen, the marsh is not eroding, and as a result this is not an issue. Determining the potential for a mined area to spread into another area via erosion is achievable if the geomorphologic conditions are analyzed with topography.

As seen in Skallingen, spending more time on NTS and TS can make mine clearance more efficient, save funds, protect the environment from unnecessary invasive clearance procedures and result in cancellation of suspected hazardous areas. In order to achieve a mine-free world, these flexible, creative methods should be utilized without restriction to traditional standard mine clearance methodology.

The author would like to especially thank explosive ordnance disposal technician Johnny Rankenberg Thomsen for his extensive work analyzing detonators and fuzes.

New Human Rights Safety Bracelet Designed

~Blake Williamson, CISR staff

In 2009 Russian human rights worker Natalia Estemirova was abducted in front of her home in Grozny, Chechnya, and murdered in Ingushetia, Russia. In response to her murder the organization Civil Rights Defenders (CRD) created the Natalia Project—a bracelet that sends out a distress signal when the wearer is in danger. Designed for those working in conflict areas, the bracelet is one component of a comprehensive security program using satellite navigation technology to send signals to the smartphones of those in close proximity (who are previously assigned by the bracelet-wearer to receive alerts) and CRD’s headquarters in Stockholm, Sweden. CRD verifies the alarm and ensures appropriate messages are posted to social media in accordance to a predefined, customized security protocol. ...
Abandoned Ordnance in Libya: Threats to Civilians and Recommended Responses by Docherty and Crowe [from page 4]


2. The Associated Press Stylebook, which is the writing styleguide that The Journal of ERW and Mine Action follows, spells Libya’s former leader’s name as Moammar Gadhafi.


6. The threats posed to civilians by abandoned ordnance often overlap with those posed by mines and unexploded ordnance (UXO).

7. While UNMAS recorded civilian casualties from ERW, this article does not include those civilian casualty figures because, as of August 2012, the available data was almost certainly incomplete due to the lack of local or central reporting mechanisms.

8. Colonel Mohammed Torgman (liaison with Joint Mine Action Coordination Team and member of the Military Council of Misrata), interview with IHRC, Misrata, 29 March 2012.


15. UNMAS, for example, has been establishing relationships with local authorities and militaries to facilitate the separation of items that are dangerous if stored together and the relocation of stockpiles to more remote locations. In Sabha, after a March 2012 meeting with UNMAS technical advisers, the civilian council agreed to assist the military council in storing ammunition in appropriate facilities. “Joint Mine Action Coordination Team—Libya Weekly Report 6 March, 2012.” JMACT. 6 March 2012. http://bit.ly/1230md2. Accessed 22 July 2012.


20. Alexandra Arango (community liaison manager, MAG), interview with IHRC, Misrata, 29 March 2012.

21. Teresa Tavares (risk education project manager, Handicap International), interview with IHRC, Misrata, 30 March 2012; Amira Zeidan (community liaison manager, MAG), interview with IHRC, Zintan, 28 March 2012.


23. Because the Ministry of Health program was not dedicated to ERW victims, a detailed analysis and evaluation of the program was outside the scope of the report.


28. Sabri Ebdawi (chief executive officer, Green Libya Petrol Services, and civil society member of the National Program), interview with IHRC, Tripoli, 10 July 2012.

Weapons and Ammunition Security: The Expanding Role of Mine Action by Rice [from page 8]


Cluster Munition Remnant Survey in Laos by Creighton, Karlsen and Qasim [from page 12]


Assessment of Vietnam’s National Mine Action Program by Paterson and Griffths [from page 17]

1. In Vietnam, this war is called the American War.


Securing Health Care Rights for Survivors: Developing an Evidence Base to Inform Policy by Durham [from page 22]


12. World Health Organization definition of disease: Any condition that causes pain, dysfunction, distress or death to the person afflicted.


Association for Empowerment of Persons with Disabilities in Quang Binh, Vietnam by Nga [from page 26]


6. Email correspondence with Nguyễn Thị Thúy Nga. 12 December 2012.

7. Peer support is encouragement and assistance provided by a trained survivor who successfully overcame a traumatic experience to engender self-confidence and autonomy.


9. In an effort to relay Nguyen Duc Ve’s story to other survivors, multiple AEPD staff worked with a writing consultant to compile Ve’s story into an uplifting anecdote of his numerous business ventures.

Mass Fitting for Amputees in Tam Ky by Rutherford [from page 30]

1. In Vietnam, the Vietnam War is called the American War.

Addressing Underwater Ordnance Stockpiles in Cambodia by Tan [from page 32]


4. Participants who did not continue either selected to return to their jobs or were asked to leave because they were slow to acquire the skills.

5. Scuba theory is the knowledge base of physics and physiology necessary for successful underwater diving.

WWII Cleanup: Munitions Contaminate German Seas by Braun [from page 40]


A Stand-off Seismo-acoustic Method for Humanitarian Demining by Bechtel [ from page 52 ].


8. USB stands for Universal Serial Bus.

9. RTV stands for Room Temperature Vulcanizing.

10. This statement refers to some very brief tests the author did specifically to find an optimum sensor height for her tests.

11. ASCII stands for American Standard Code for Information Interchange.

Analyzing Functionality of Landmines and Clearance Depth as a Tool to Define Clearance Methodology by Jelens [ from page 57 ]


2. Components of heterogeneous mixtures combine in suspension. They separate into their original parts (similar to how oil and water mixtures separate). They remain in suspension when mixed, then settle out of suspension.


4. Digital orthophotos are scaled aerial photographs that can be used as a base map in a GIS or as a tool to revise digital-line graphs and topographic maps. http://bit.ly/V54680.


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Harrisonburg, VA 22807 / USA
Email: rutherkr@jmu.edu
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FEATURE: Residual Clearance
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ISSUE 18.2 (Submissions due 15 February 2014)

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ISSUE 18.3 (Submissions due 15 July 2014)

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How is IED clearance different from mine clearance? What are best practices in IED detection and risk education? What threats do IEDs pose to the humanitarian demining community? What practices for physical security and stockpile management best prevent the illicit use of military munitions in IEDs?

SPECIAL REPORT: Pacific Islands
What cultural, social, economic, and environmental effects has contamination had in the region?
Preventing Unplanned Explosions at Munitions Sites

Unplanned explosions at munitions sites (UEMS) frequently result in contamination and destruction similar to that resulting from conflict. Preventive measures can reduce the risk of UEMS and are significantly easier to deploy than clearance after an explosion.

by Chris Loughran and Daan Redelinghuys [MAG]

International concern over unplanned explosions at munitions sites (UEMS) has grown considerably in recent years. UEMS have garnered significant media attention as a result of the large number of civilians killed or injured by these explosions. Efforts by states, the U.N., international and nongovernmental organizations (NGO), and research institutes have focused on the scale and nature of the problem while developing initiatives to prevent unplanned explosions.

Tragically, unplanned explosions often occur in populated areas. For example, fire at a munitions site in northern Lagos, Nigeria, caused an explosion in 2002, killing more than 1,000 civilians.\(^1\) In July 2011, a similar munitions explosion destroyed the largest power plant in Cyprus.\(^1\) In 2012, the series of explosions that occurred at a military site in the center of Brazzaville, Republic of the Congo (ROC), was one of the largest incidents in recent years. Immediately following the explosion, global attention focused on the enormous human and economic impact of UEMS.\(^1\)

The Small Arms Survey found 302 instances of unplanned explosions in 76 countries between January 1998 and October 2011.\(^2\) As a result of such explosions, communities are rendered homeless, and rescue workers fight fires and find survivors and bodies in the rubble of collapsed buildings, all shown on international media and the Internet.

Consequences of UEMS

Recognition is growing of the long-term social and economic consequences of UEMS, which are typically less visible but extend far beyond the immediate loss of life and the financial costs associated with emergency response. The closure of industrial sites, businesses and trading centers has long-term consequences for business owners and employees. Hospitals, schools and municipal facilities in the blast radius may remain closed for weeks or even years. Government budgets invariably need to
reprioritize significant costs of reconstruction over multiple years. For example, the Brazzaville explosion destroyed hundreds of homes and businesses, leading to the temporary closure of schools and a hospital. An estimated 5,000 people lost their homes.

From a mine action perspective, emergency response operations need to incorporate explosive ordnance disposal (EOD) support to enable safe access for emergency responders while also systematically identifying and destroying unexploded ordnance (UXO). UXO can be projected a considerable distance from the explosion site and are often highly unstable. In most cases, reporting systems and risk education in communities that have not previously experienced the risks associated with contamination from UXO must accompany EOD operations.

For the international mine action community, UEMS occurring in countries with a limited EOD or mine action-coordination capacity can trigger emergency response deployments and operations usually associated with a post-conflict environment. In many respects, the effect of an unplanned explosion is similar to the impact of conflict, including longstanding, extensive damage to infrastructure.

**Preventive Measures**

While the availability of expert clearance, risk education and coordination support after an incident is important, devoting the same technical expertise and resources to prevent or reduce the risk of such incidents is preferable. Purely in terms of operational costs, post-explosion clearance is vastly more expensive than preventive measures to improve weapons and ammunition management and destroy surplus munitions.

The management of stockpiles is a broad and detailed subject, but the key principles relevant to the causes of UEMS (including the escalation of a single explosive event to a catastrophic disaster like that seen in Brazzaville) are not complex. Munitions do not have an indefinite shelf life; they degrade over time, and storage conditions significantly impact their expected lifespan. Physical factors such as temperature, humidity and rough handling affect shelf life, making explosives unstable and at greater risk of not functioning as intended.

While munitions are designed for continual maintenance throughout their life cycles in ways that maximize shelf life, they also have safety parameters that minimize the effect of an explosive incident. Key safety factors include protection against fire and static electricity (including lightning) as well as stor-
Age in “compatibility groups,” with in-
compatible items (due to their chemical
composition or explosive effect) stored
separately within a storage site.

Safety measures include what is con-
sidered a safe distance for civilians rel-
ative to storage locations. These limits
reduce the risk of a single explosive in-
cident propagating through the storage
area and initiating further explosions
that result in large-scale incidents. Fre-
quently, controls over construction and
development in close proximity to mu-
nitions sites are not implemented, and
urbanization dangerously encroaches
on depots. This should require a reduc-
tion in facilities’ storage quantity or the
relocation of facilities to a new site. In
many cases, particularly in countries
with poor infrastructure, capacity and
resources, these essential safety mea-
sures are not carried out.

UEMS causes range from mechani-
cal or chemical deterioration of compo-
nents to internal or external events such
as fire and lightning, and include hu-
man factors such as improper handling
or tampering. These causes often result
from inadequate site security. Poor stor-
age practices of temporary or perma-
nent stockpiles may result in an initial
explosion leading to multiple explo-
sions, as was seen in the Brazzaville in-
cident. Reducing UEMS risk therefore
requires steps to improve the condi-
tions under which munitions are stored
and how munitions are managed. This
also involves the routine destruction of
obsolete or degraded munitions.

Many states have developed de-
tailed standards and procedures to en-
sure the safe storage and management
of military-held munitions. Since their
launch in 2011, the International Am-
munition Technical Guidelines (IATG)
have provided a normative framework
to improve munitions management. IATGs
also offer solutions to prevent
UEMS and diversion of munitions
from state stocks.

For many states, implementing and
managing even the most basic im-
provements necessary to address the
immediate causes of UEMS still face
significant challenges, including bud-
get constraints and competing priori-
ties for limited government resources.
This is particularly true for countries
with poor infrastructure and a lack of
technical expertise in munitions man-
agement. Theft presents an additional
challenge for countries emerging from
protracted conflict.

Technical Assistance

MAG (Mines Advisory Group) pro-
vides a range of technical assistance to
states, including Burundi, Libya, ROC,
and South Sudan, seeking to prevent
UEMS. Assistance typically takes the
form of storage-facility assessments and
training-needs assessments for munitions-
storage managers and supervising
officers. Assessments also identify sur-
plus and obsolete stocks, inform sub-
sequent training programs and lead to
the relocation or physical rehabilita-
tion of facilities. National buy-in for the
program is essential, as is local capacity
building.

Even in the most complex operating
environments, states can implement in-
expensive, effective steps, such as evalu-
ating munitions storage procedures and
reorganizing munitions within the stor-
age facilities, to improve the safety of
their facilities and to gain long-term
commitment from donors and greater
political support. A small degree of in-
tervention can tangibly address the
causes of UEMS and assure security of
state stocks over time. Although initial
preventive measures may require exter-
nal technical assistance and donor sup-
port, initiatives to prevent UEMS under
the broad framework of IATGs can only
be truly sustainable and effective in the
long term if they are nationally owned
and led.
Endnotes

During World War II, Nazi forces began dumping chemical and conventional weapons in the ocean to avoid devastation by enemy aerial bombings. Following the Nazi Party’s unconditional surrender in May 1945, the Allied powers continued with this practice to dispose of German arsenals. Munitions from WWII still pollute German coastal waters, mainly the result of large-scale weapons-dumping between 1945 and 1948. According to Germany's Program on Underwater Munitions, eight dumpsites in the North and Baltic Seas contain 1.6 million metric tons of aerial mines, bombs, shells and unexploded ordnance (UXO). Of these, roughly 14 percent, or 230,000 tons, are chemical munitions.

Since 1947, hundreds of Danish fishermen have been injured by mustard gas munitions mixed in with their catches. In 2005, three fishermen caught a bomb in their nets and were killed when it exploded on the vessel. Danish sailor and fisherman Lorenz Marquardt pulled a 500-kg (1,102-lb) bomb onto his boat alongside his catch in April 2013. In Germany’s Usedom North region in 2012, two female tourists from Saxony and Saxony-Anhalt became victims of a phosphorous flame (which had leaked from incendiary bombs), leaving them with second- and third-degree burns. This was the 12th incident reported in the region since 1990.

In addition to injuries, underwater contamination has slowed offshore construction of wind farms and pipelines. Boskalis Hirdes, a German company specializing in underwater construction, was hired to install wind turbines off the German coast. While undertaking the project, Boskalis Hirdes' technical director, Jan Kölbl, shared that they were laying cable on one specific route where they expected to find 50 items of UXO but instead discovered 2,000.

According to Kölbl, because the ammunition is unstable, controlled detonations in situ are often the only safe option for disposal. These detonations, however, have severe detrimental effects on marine wildlife. Environmental organizations like Naturschutzbund Deutschland have “issued demands for legal guidelines” on clearance of underwater UXO and explosive remnants of war. Kölbl said that such guidelines would be helpful. Although the German government has yet to perform clearance, the Program on Underwater Munitions focuses on technical research, reporting and documentation, and monitoring and mapping in order to fully understand the contamination’s extent.

~ Dan Braun, CISR staff

Endnotes
Prevention of Unplanned Explosions at Munitions Sites in Tajikistan

Poorly stored stockpiles of aging munitions continue to pose threats in Tajikistan. Since 2009, the Fondation Suisse de Démimage (the Swiss Foundation for Mine Action or FSD) has worked with Tajikistan’s Ministries of Defense and Interior and its border guards to dispose of surplus weapons and munitions. These efforts were funded by the government of the Netherlands and the Office of Weapons Removal and Abatement in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/WRA).

With the dissolution of the Soviet Union in the early 1990s, former Soviet republics inherited vast amounts of Soviet weaponry from military units previously stationed in these now independent republics. Three of these countries, Turkmenistan, Uzbekistan and Tajikistan, served as staging points for Soviet forces during the invasion of Afghanistan in the 1980s and produced and maintained considerable stocks of Soviet weapons and munitions. When Tajikistan entered into civil war in 1992, these former Soviet armories (still occupied by idle Soviet units) served as a major source of small arms for both government and opposition forces. Other sources of small arms came from high-ranking local law enforcement officers who appropriated the weapons available to them, as well as from Afghanistan, Kyrgyzstan, Russia and Uzbekistan. With the war ended in 1997, thousands of tons of munitions were left unguarded in makeshift storage sites, many of which were forgotten. Today, the munitions stored in these abandoned caches continue to decay, increasing the likelihood of unplanned explosions. Moreover, these caches, some of which include weapons such as mortars, heavy machine guns, rocket-propelled grenade launchers and shoulder-launched surface-to-air missiles, have reportedly been targeted by criminals and militant extremists and pose a serious security threat to the Tajikistani people.

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Although demilitarization programs operated across the country during and after the civil war, recent clashes in Tavildara (2009), Gharm (2010) and Khorugh (2012) with armed groups show that citizens continue to possess a considerable amount of small arms and light weapons (SA/LW).
Unplanned Explosions

A survey conducted by the Small Arms Survey indicates a more than two-fold increase in unplanned explosions at munitions sites globally since 1987, with 69 events from 1987–1996 and 194 events from 1997–2006. Although there are no official statistics available, there was at least one unplanned explosion in Tajikistan in 2009 caused by handling errors and poor working practices.

While unplanned explosions tend to originate from mechanical and chemical deterioration of ammunition brought on by poorly met standards within storage depots, additional risk factors exist:

- Storage area defects such as electrical short circuits
- Negligent behavior including dropping ammunition or smoking in the facility
- Environmental dangers such as extreme temperature shifts, lightning or fires

In Tajikistan, summer temperatures can reach upward of 50 degrees Celsius (122 degrees Fahrenheit), and the dry climate increases the likelihood for fires.

Reducing the number of unplanned munitions explosions may require additional training for staff working at storage sites. Likewise, constructing new storage facilities and renovating existing structures will eliminate external and environmental threats. Problems related to deteriorating munitions can only be solved by separating them from stable munitions and disposing of the unstable munitions.

Weapons and Ammunitions Disposal

In 2003, the Fondation Suisse de Déminage (the Swiss Foundation for Mine Action or FSD) signed a memorandum of agreement, which the Majlisi Oli (Tajikistan’s Supreme Assembly) ratified on 20 June 2003. Tajikistan’s inability to properly secure and maintain its munitions sites alerted FSD of the need for a Weapons and Ammunitions Disposal (WAD) team in Tajikistan. In April 2009, FSD and Tajikistan’s First Deputy Minister of Defense, Lt. Gen. Ramil Nadirov, met and initiated the WAD project.

Besides conducting munitions disposal, FSD’s other activities in the region include landmine and explosive remnants of war survey, clearance and land release. FSD’s WAD project is the only Tajik program actively operating in weapons, small-arms and ammunition disposal and is supported by Tajikistan’s border guards, Ministry of Defense (MOD) and Ministry of Interior (MOI). Its objectives are as follows:

- To train and provide necessary equipment for teams consisting of FSD and MOD staff for the destruction of unserviceable, outdated and redundant conventional ammunition
- To facilitate SA/LW, large-caliber ammunition, aircraft
bombs and man-portable air-defense systems (MANPADS) destruction
• To improve munitions-stockpile security and management through relevant staff trainings\textsuperscript{a}

The government of the Netherlands funded the first team to conduct WAD operations starting in May 2009 and has continuously assisted the WAD team for nearly three and a half years. Over this period, the Netherlands contributed more than EU€1,000,000 (US$1,277,300 as of 4 April 2013) to FSD.

In 2011 and 2012, the Office of Weapons Removal and Abatement in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/WRA) provided Tajikistan with more than US$2.5 million to support WAD teams and mine action in Tajikistan.\textsuperscript{a,b} The total PM/WRA contribution for Tajikistan in 2011 was US$1 million, and the 2012 total was $1,691,120. Through fiscal year 2012, the U.S. invested more than $6.8 million in conventional weapons-destruction (CWD) programs in Tajikistan.\textsuperscript{9}

Program Results

From 1 May 2009 to 31 December 2012, WAD project teams achieved the following results:
• 154,952 rounds of ammunition of 20-mm caliber and higher were destroyed by using a high explosive attack method.
• 1,025,155 small arms ammunition from 5.45-mm to 14.5-mm caliber were destroyed in incinerators designed locally by FSD’s technical staff in Tajikistan.
• 7,180 light weapons and their components were destroyed with high pressure hydraulic shears.\textsuperscript{11}

During a 2012 examination of depots throughout the country, Tajikistan’s MOD officers and WAD staff also found 645 anti-personnel mines, which later were destroyed at FSD’s central demolition site near Dushanbe. Other notable munitions were found as well:
• 116 anti-tank mines from depots
• 400 cluster munitions
• 40 MANPADS

Two refresher courses and three courses in ammunition safe-handling and explosive-ordnance disposal (EOD) at each of the three International Mine Action Standards levels were carried out from 2009–2013. Additionally in 2012, two SA/LW Cutting Standard Operation Procedures courses were given to MOI and border guard officers. Altogether, 82 civilians,
25 officers from the MOD Engineering Department, eight officers from MOI and five border guard officers attended courses and were successfully accredited as EOD operators.

Physical security and stockpile management (PSSM) issues continue to present serious security concerns to Tajikistan, and FSD strives to support the government in resolving these issues. Additionally, the government of Tajikistan continues to take steps to improve stockpile security. On 3 January 2013, deputies of Majlisi Namoyandagon (Tajikistan’s lower house of parliament) ratified a PSSM agreement between Tajikistan and NATO. FSD hopes the MOD, together with the MOI, will take ownership and manage the PSSM project in the near future; however, no concrete steps to transfer control of the project have been taken at this time.

Endnotes

11. Program results taken from the FSD WAD database, Artyom Harutyunyan, email correspondence with author, 7 June 2013.
From Church Mission to Invention

After a mission trip to improve the sanitation needs of orphanages in Cambodia, Gary Christ recognized the great need for a better demining machine and developed the “Peacehammer.”

by Gary Christ

During my first five-week mission trip to Cambodia, I did not focus on helping landmine survivors. Rather, I accompanied my pastor to survey sanitation needs of orphanages. Licensed to install septic systems, I used my expertise to design a wastewater treatment system to prevent the children from getting sick. My first impression of the sanitation problems in Cambodia drove me to innovate and implement a new type of septic system. However, every time I tried to purchase septic supplies, I heard a common Khmer phrase, "ot mien," which translates to "have not." Supplies were inadequate; shovels, gloves, washed septic stone, septic tanks and backhoes were either insufficient or unavailable.

Challenges help us to grow, which I did. Quickly learning to use the Asian-style hoe to dig a trench, I made septic tanks from well rings and formed concrete chambers, a gravel-free method of draining wastewater. On my next trip, I shipped a container-load of higher quality shovels, plastic septic chambers and other supplies that enabled our team of Cambodian orphans and American missionaries to install a dozen septic systems at orphanages throughout Cambodia.
While installing the 13th septic system, the installation team unexpectedly encountered an unexploded landmine. Thankfully, the Cambodian Mine Action Centre (CMAC) removed it before anyone was injured. At that moment, I had an epiphany: "Could landmines be safely detonated by weights dropped from a crane?"

Taking an Idea to Invention

Shortly before the mine incident occurred in 2005, I met retired Captain Sem Sovantha, a landmine survivor and founder of the nongovernmental organization (NGO) Angkor Association for the Disabled (AAD). Although a Khmer Rouge landmine tore off both of his legs in 1990, he survived. After eight months in a military hospital, Sovantha was forced to beg on the streets of Phnom Penh to provide food for his family. In 2004, he started AAD to provide shelter for other landmine victims and give them an opportunity to learn a trade. Sovantha has helped countless other persons with disabilities and their families. In my opinion, he is a Cambodian hero.

Interested in inventing a new type of demining machine, I continued to ponder how best to eliminate the landmine threat. When I expressed my interest in creating a new landmine machine to Sovantha, he referred me to everyone he knew who might help. At that time, several NGOs used a variety of techniques and machines to meet Cambodia’s goal of being free from landmines and unexploded ordnance (UXO) by 2010; this date has now extended to 2020.

I learned much from Aki Ra, founder of the Cambodian Landmine Museum and Relief Facility and Cambodian Self Help Demining; H.E. Heng Ratana, Director General of CMAC; and from MAG (Mines Advisory Group) and the Development Technology Workshop, which co-developed the Tempest machine with U.S. Humanitarian Demining Research and Development Program. Although I had zero experience with landmines, Sovantha’s contacts were very respectful. They recognized that Sovantha and I wanted to help make Cambodia a safer place.

The Peacehammer

By speaking with deminers and engineers, I learned that demining machines need to be thoroughly developed. My concepts were good, but prototypes were needed. After returning home to the U.S., I dedicated my free time to modifying obsolete machines and my 1947 tractor to make a simple crane with a heavy hammer. Thanks to a team at Hydraulic Services & Repairs and Eric Hammerstead and Dave Hammerstead of Mobile Lift Sales & Service, who helped fabricate the “Peacehammer,” and philanthropist Margaret Dawbarn,
Endnotes


2. The author cannot provide accurate statistics to support this claim at this time.

New Human Rights Safety Bracelet

In 2009, Russian human rights worker Natalia Estemirova was abducted in front of her home in Grozny, Chechnya and murdered in Ingushetia, Russia. In response to her murder, the organization Civil Rights Defenders (CRD) created the Natalia Project—an effort to distribute and monitor a bracelet that sends out a distress signal when the wearer is in danger. Designed for those working in conflict areas, the bracelet is one component of a comprehensive security program using satellite navigation technology to send signals to the smartphones of those in close proximity (who are previously assigned by the bracelet-wearer to receive alerts) and CRD’s headquarters in Stockholm, Sweden.1, 2, 3 CRD verifies the alarm and ensures appropriate messages are posted to social media in accordance to a predefined, customized security protocol. Security protocols vary depending on the user and situation; CRD intends to determine how best to react to an emergency situation by evaluating possible scenarios and relevant actors in area.1

The wearer can manually activate it, and the bracelet automatically sends out a distress signal if forcefully removed. CRD can disable a false positive, however, by verifying whether the user is in danger. CRD encourages the wearer’s online community to monitor the bracelets via social media.1, 4 Optimistic about the bracelet’s potential to save lives, CRD Executive Director Robert Hardh points out that wearing the bracelet in a dangerous area is akin to “walking around with millions of people on your arm.”5

A commercially available option that “combines wearable GPS devices with alert function, mobile monitoring interfaces and smartphone applications” can be purchased from PFO Technologies, the manufacturer of CRD’s bracelet.6 The special security features discussed above are unique to CRD’s Natalia Project, but PFO’s commercial product includes GPS and other safety features that the demining industry would find useful.1, 7 Although kidnapping of deminers is not generally a frequent occurrence, it does happen. For instance, members of the Movement of the Democratic Forces of Casamance (MFDC) abducted 12 deminers in Senegal in May 2013.8 That same month, the Taliban in Afghanistan kidnapped 11 deminers.9 Safety bracelets would have easily tracked those kidnapped and quickly alerted authorities to the problem.10

The CRD bracelets have been tested, and the first five were ready for local human rights defenders (people working on human rights issues who are threatened and harassed by their own governments or security services) in the North Caucasus in May 2013.1 CRD hopes to provide 50 more by the end of 2014.3 Bracelets associated with the Natalia Project will go to those working in the most dangerous areas within CRD’s existing networks in East Africa, Eastern Europe, Central Asia and Southeast Asia.1, 8

~ Blake Williamson, CISR staff
The Regional Center for Divers Training and Underwater Demining

The Regional Center for Divers Training and Underwater Demining (RCUD) in Bijela, Montenegro, trains divers from around the world to properly handle and dismantle weapons located underwater. Since the organization’s creation in 2002, it has removed more than 120 tons of explosive material.

by Veselin Mijalović [Regional Center for Divers Training and Underwater Demining]

Beginning during World War I (WWI) and continuing after WWII, several world powers dumped excess chemical and conventional weapons in oceans around the world. Remaining from WWI and II and other conflicts, weapons and munitions, either dumped or abandoned, contaminate major oceans and waterways worldwide. In 1975 the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (also known as the London Convention) officially banned the practice of dumping chemical weapons, and the London Protocol, a modification of the London Convention, updated the original convention and further prohibited maritime dumping in 1996.

Unlike action taken to end weapons dumping, no current international legislation prohibits using underwater mines. These mines are purposefully placed in oceans and rivers. They have been used as far back as during the American Revolutionary War to more recently, such as during the 1980–1988 Iraq-Iran conflict. Some underwater mines are designed to sink to the ocean floor and cause deep explosions, while others float at the water’s surface and are meant to explode close to ships. Mines, including underwater mines, are still used by nonstate actors, terrorist groups, and nations as they are easy to build, cost-effective to develop, hard to detect and extremely effective. Even threats of underwater mines can lead to the closure of key waterways necessary for international trade—such as the Strait of Hormuz or the Suez Canal among others.

Collectively, dumped weapons and munitions and underwater mines pose dangers to maritime industries—including fishing, ocean trade and transportation, tourism and water sports such as diving, oil drilling, and wind energy—as well as to ocean and underwater ecosystems around the globe.

RCUD

Due to the high number of underwater mines and dumped unexploded ordnance (UXO) from previous conflicts in and around Montenegro, the government of Montenegro established the Regional Center for Divers Training and Underwater Demining (RCUD) in 2002. The South-Eastern Europe Mine Action Coordination Council (SEEMACC) and the Office of Humanitarian Demining Program in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/HDP) had essential roles in the establishment of RCUD. PM/HDP and its successor organization, the Office of Weapons Removal and Abatement in the U.S. Department of State’s Bureau of Political-Military Affairs (PM/WRA), provided RCUD with millions of dollars of support in the form of equipment, underwater clearance tasks, and diver training projects, through PM/WRA’s implementing partner, the Slovenian organization ITF Enhancing Human Security (ITF). ITF has been PM/WRA’s main implementing partner for conventional weapons destruction, including humanitarian demining, in the Balkans.

RCUD is located in Montenegro in the town of Bijela on the coast of the Bay of Kotor. Montenegro’s own revenues, its state budget, and donations from other countries and organizations fund the organization. RCUD employs nine professional anti-mine divers and 11 logistical staff.
Operations

To help to meet international needs related to underwater clearance, RCUD trains underwater deminers from around the world. Before RCUD's establishment, no civilian institution of its kind existed in Europe that conducted humanitarian underwater demining and UXO removal while also training underwater deminers from other countries. RCUD coordinates, manages and unites the organizational, technical and professional levels of training affiliated with the implementation of underwater demining. This includes the critical practice of monitoring, supervising and protecting people and property from UXO during underwater demining operations. RCUD cooperates with state institutions, nongovernmental organizations (NGO) and international institutions to ensure efficient and safe use of water resources.

In addition to conducting underwater demining and training underwater demining divers, RCUD

- Drafts plans for underwater research and for protection of the population from underwater UXO
- Participates in studies and mapping of underwater minefields
- Coordinates institutions and individuals in Southeast Europe and in other countries in humanitarian underwater demining

Diver and Deminer Training

Members of government disaster-relief agencies, as well as members of military and police units in countries with UXO-contaminated waters, obtain training at RCUD. Training is performed according to the Standard Operating Procedures for Humanitarian Underwater Demining in South Eastern Europe adopted in 2004 by SEEMACC members. From 2002 to 2010, RCUD trained 48 professional divers and 12 supervisors from Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Russia, Serbia and Slovenia for underwater demining and other underwater work.

Divers who attend the training must have the recommendations of their national armies or police. To attend
the four-week training, divers must have completed separate training in dealing with explosives on land, obtain a certificate logging a minimum of 300 hours of diving issued by state institutions, have a healthy medical certificate and pass psychophysical testing.

RCUD underwater demining divers learn and gain experience in:

- Understanding the effects of explosives and the chemical reactions of pyrotechnic mixtures in water
- Handling ordnance and explosives in water
- Assessing sabotage of underwater ordnance
- Working with various ERW and mines and with specific fuze and mechanism activation
- Detecting explosives through various methods and means
- Learning different methods for deactivating or destroying explosives in water
- Organizing and implementing intervention and rescue in the water
- Communicating in the water through various methods such as telephone communication between divers, between divers and the surface, or communication through a “lifeline rope” strung between the diver and the surface
- Practicing first aid
- Learning protective measures for handling UXO in water
- Transporting UXO underwater, over water and on land

RCUD’s Demining Progress

As of 2013, RCUD has demined approximately 2 million sq m (494 ac) underwater and destroyed approximately 120 tons of anti-ship mines and other explosive items. RCUD uses the latest technology for its underwater demining including the latest underwater mine detectors, side-scan sonar, georeferenced underwater equipment and remote-controlled parachutes/lifting bags for removing ordnance from the ocean floor. RCUD also employs highly qualified international instructors and other experts in the field of demining. In July and August 2012, three diving teams affiliated with RCUD removed 2.5 tons of explosives from the Zeta River in Montenegro. Among the explosives were grenades, cluster bombs and cannon balls.3 RCUD also removed an aircraft bomb from the Moraca river in the center of Podgorica, Montenegro in August 2012.4

One of the most complex tasks in the field of demining is removing explosive devices under the sea’s surface. This type of underwater demining requires specially trained divers and equipment.

Endnotes

RCUD deminers perform underwater UXO reconnaissance of the riverbed adjacent to the Chelopechene depot disaster site near Sofia, Bulgaria, using an underwater metal detector produced by Ebingr.

