CHAPTER 6

DEMINING

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SUMMARY

Demining covers the range of activities which lead to the removal of the threat from landmines and explosive remnants of war. These include survey, risk assessment, mapping, marking, clearance, post-clearance documentation, and the handover of cleared or otherwise released land.

Physical clearance is only one part of the demining process, but it is the most costly part. Mine action has developed a toolkit approach to mine and ERW clearance, using and combining, as appropriate, manual deminers, mine detection animals and mechanical demining equipment, such as vegetation cutters, tillers and flails and other appropriate assets. Explosive ordnance disposal and battle area clearance rely primarily on specialist personnel to render safe or destroy explosive remnants of war.

INTRODUCTION

This chapter looks at demining, one of the five pillars of mine action as defined by the United Nations and by far the most costly and time-consuming. Many affected States, whether or not they are party to the main international instruments governing landmines or other explosive remnants of war (ERW), have sought outside assistance to address the contamination on their territory and return land safely to the civilian population. At the forefront of this international effort have been the UN, international and indigenous NGOs, local and visiting militaries, and commercial companies.

The first section of the chapter describes the international definition of demining. The chapter then describes the various types of assessment and survey that support tasking and prioritisation of clearance operations. This is followed by an overview of the different techniques for carrying out mine and other ERW clearance. This includes the requirement for quality control and assurance and the definitions of battle area clearance and explosive ordnance disposal. Finally, the chapter considers the international legal framework for demining.

WHAT IS DEMINING?

The International Mine Action Standards (IMAS) define the term demining as referring to *"activities which lead to the removal of mine and UXO hazards, including technical survey, mapping, clearance, marking, post-clearance documentation, community mine action liaison and the handover of cleared land."*[1] The IMAS notes that demining may be carried out by different types of organisations, such as NGOs, commercial companies, national mine action teams or military units.[2] Demining may be emergency-based or developmental.[3]

ASSESSMENT AND SURVEY

The first step in planning effective demining operations in a new mine action programme is typically to initiate a General Mine Action Assessment (GMAA).[4] As the relevant IMAS points out, the GMAA is *"the continuous process by which a comprehensive inventory can be obtained of all reported and/or suspected locations of mine or UXO contamination, the quantities and types of explosive hazards, and information on local soil characteristics, vegetation and climate; and assessment of the scale and impact of the landmine problem on the individual, community and country"*.[5] Such an assessment largely uses secondary sources, for instance, existing information provided by agencies and organisations familiar with the area and the contamination.

Minefield warning | Lebanon

An assessment mission can be used to validate and update existing information, and to determine at first hand the scale and impact of the landmine situation. If undertaken by the United Nations, the country assessment can determine whether a UN-supported national mine action programme is required, whether such a programme is possible or what other action is required. It may also define the scope of additional information gathering requirements. A 'general' survey of contamination may follow: the primary aim of such a survey is to identify the location of suspected hazardous areas across the country and the type of contamination they contain.

Impact surveys

Beyond a general survey, and in order to obtain a much better picture of how contamination is affecting the lives and well-being of the civilian population, many countries have conducted a national or provincial survey of the socio-economic impact of mines and ERW impact on communities. One well-known such survey is the Landmine Impact Survey (LIS). A complete LIS, which typically takes one year or more to complete, aims to provide a detailed and reliable report of the impact of mine and ERW-contaminated areas on local communities.

Preliminary opinion collection, which normally takes place over several weeks in-country, helps to narrow down the areas and communities to be surveyed. Visits to local communities narrow (or expand) the list further. The community survey process uses specially trained teams to gather demographic, contamination, social and economic data in every community suspected to be affected.

Using a scoring system that is adopted in-country using national input to take account of local conditions, a priority listing classifies communities as having heavy, medium, low or nil mine or ERW impact. Sampling is then conducted for false negatives and additional community surveys conducted as necessary. The results of the survey are typically entered into the Information Management System for Mine Action (IMSMA) database for the country. IMSMA is described in Chapter 13.

The criticism of some impact surveys is that they can generate a high number of 'false positives' – reports of areas as hazardous when in fact they contain no explosive contaminants at all. Moreover, where they seek to calculate the size of suspected hazardous areas (SHAs) purely on the basis of local opinion, this can result in greatly exaggerated estimates of contamination. These can waste precious resources and also hinder resource mobilisation efforts, as the scale and extent of the problem is perceived by donors to be too vast to be effectively addressed.

Technical survey and area reduction

General or impact surveys will identify many suspected hazardous areas (SHAs) in a country or region. But such surveys do not physically confirm that within these SHAs there are in reality contaminated areas, nor do they verify or mark and map the precise outer limits of mined areas. For this reason, a technical survey has to be carried out. Such a survey will confirm or discredit the presence of mines or ERW in an SHA, and sometimes identify the perimeters of the mined area or ERW-contaminated area or location.

According to IMAS, technical survey is *"the detailed topographical and technical investigation of known or suspected mined areas identified during the planning phase. Such areas would have been identified during any information gathering activities or surveys which form part of the GMAA process or have been otherwise reported"*.[6] The output of a technical survey may also include perimeter marking to reduce the risk of unintentional entry into the hazardous area, normally as part of a comprehensive mine risk education programme. If clearance does not immediately follow a technical survey, then survey markers are left securely in place, enabling the hazardous area to be located accurately and safely at a later date.

It is, however, an unfortunate reality that most mine clearance is still conducted on land that proves to be free of contamination. For that reason, area reduction efforts (the reduction or cancellation of suspected areas) are growing in importance, especially in heavily affected countries.[7] The distinction between technical survey and area reduction, both of which are typically undertaken using machines, mine detection animals or deminers using metal detectors, remains unclear. What is certain is that all available methods require specialised and well-trained personnel. To seek to identify the most effective methods of area reduction, the GICHD expects to complete by the end of 2007 a study of area reduction methodologies (Risk Management and Land Release).

Risk Assessment

According to the IMAS, the objective of mine action is to *"reduce the risk from landmines and UXO to a level where people can live safely"*.[8] This does not, however, imply a requirement to physically clear every square metre of land in a country. For, as already noted, the impact survey process has typically overestimated the area suspected to be affected by mines and ERW.

The gap between the technological capacity for clearance and the requirement to release land for use by the community is still huge and there is as yet no technological solution available for this. Technical Survey and area reduction are part of the processes that enable the sparse and expensive clearance resources to be focused more effectively. There are other methodologies available to the mine action community to help with this process and with the effective allocation of resources to those areas where the impact of those resources will be highest.

These methodologies vary but retain the principle of targeting those areas or populations most at risk. At the strategic level, thorough data analysis leading to a more targeted approach for resources can be one option. At the field level, a methodological approach to the use of tools and processes can provide field operators with guidance and protection on alternate methodologies for land release other than purely physically clearing the ground. This is often referred to as risk management.

While risk management principles are still relatively new in the mine action sector, they are rapidly becoming more widely accepted and it is likely that in the near future, risk management principles and methodologies will be applied in the majority of mine action programmes.

MINE CLEARANCE

Basic principles

The aim of mine clearance is the identification, and then removal or destruction of all mine and other explosive hazards from a defined area to a specified depth. The managers of demining programmes must aim to make cleared land 100 per cent safe for their use. This requires management systems and clearance procedures which are appropriate, effective, efficient and safe. The local community should also receive regular briefings and explanations during the clearance operation from the demining organisation; this acts as a very effective confidence-building measure. Community mine action liaison is an integral part of the demining process and can be achieved by the services of a mine risk education team or by suitably-trained members of the demining organisation.

Within mine action, deminers often talk of a 'toolkit' approach to mine clearance for humanitarian purposes. This is typically composed of three elements: manual mine clearance, mine detection animals (dogs and rats), and mechanical mine action systems. Most landmines and ERW are still cleared manually, although machines and animals are playing an ever-increasing role in demining operations. In addition to the nature and extent of the munition threat, logistics, infrastructure, security, national legislation and practices, and terrain will all be factors in determining which demining techniques are best used and in which combinations. The three tools in the demining toolkit are now discussed in turn.

Manual mine clearance

Overall, manual mine clearance has changed little since the 1939–1945 War. Techniques still rely on a deminer going along a lane using a metal detector or prodder until he or she encounters a suspicious object. The deminer then carefully excavates the object and, if a mine or item of explosive ordnance is uncovered, it is either blown up in situ or defused and moved for destruction at the end of the day. Average rates of clearance appear to be in the region of 15 to 20 square metres per deminer per day.[9]

The metal-cased mines of the 1940s period were comparatively easily detected by the metal detectors of the day, although the detectors were often heavy, cumbersome, insensitive, uncomfortable to use and unreliable. With the increasing use of plastics in mine construction, the metal component of the mine decreased sharply. Soon the metal components were confined to the firing pin and spring, and parts of the arming mechanism. To match the decreasing metal content, modern detectors have increased in sensitivity and, with the high usage found in mine clearance, detectors have also improved in lightness, reliability and ease of use.

Unfortunately, as sensitivity has increased so has the susceptibility of metal detectors to false alarms from small fragments of metal in the ground, sometimes splinters from exploded shells or rocket warheads, or food and beverage cans. Sensitivity is also increased to metallic compounds in certain soils, such as laterite, a common road-making material in South-East Asia and Africa. Despite these limitations, metal detectors remain the most commonly used form of detectors and considerable improvements in their design continue to be made. There are various types of metal detector, all of which are based on electromagnetic induction. Modern metal detectors have an increased sensitivity towards metal objects and the ability to discriminate between these objects and metallic compounds in the soil. While these features are important, it is equally important that detectors are practical to use and recharge as well as being durable, easy to repair and requiring little maintenance.

A 2005 GICHD study on manual mine clearance concluded that to improve the efficiency of manual mine clearance using a metal detector, the main area for improvement is the speed with which metal fragments can be identified and removed.[10] Thus, it reiterated a finding of field trials conducted for an earlier study whereby: *"in a heavily fragmented area, the most efficient method of clearance among eight different options was using a metal detector and a magnetic brush-rake."*[11] The study also showed that the efficiency of clearance can be significantly improved by applying alternative deployment procedures to the ones most commonly in use today. For details of the most effective mine detectors currently in use, see for instance the GICHD publication *Metal Detectors and PPE Catalogue 2007*.

The demining prodder, still in use as the final physical check of the presence of the mine, has gone through some development, but in most areas remains in its basic form. Prodders were conceived as simple, cheap and effective tools. Prodders have been made from many materials, from expensive plastics down to small gauge reinforcing bar retrieved from damaged buildings. Most demining organisations have replaced prodding with excavation tools and the prodder is therefore in less use today than some five years back.

The disadvantages of the prodder are its increased cost as it has increased in sophistication, and the fact that it brings the hands and sometimes the face of the operator close to the mine. In some theatres, the rocky areas demand that the prodders are stiff, to pierce through stony soil, and short military bayonets have been used, which has led to incidents of injuries to hands and eyes. Prodders can also become hazardous to use against mines equipped with an anti-disturbance fuse. Another disadvantage of the prodder is that to engage the side of the mine, it has to be inserted at a shallow angle, usually about 30° to the ground. Since many prodders are around 30cm in length, this means that they cannot penetrate the ground more than about 10-14cm in depth. In many cases, anti-personnel mines are buried at about this depth or less, while anti-vehicle mines are 10cm deeper. To insert the prodder at a steeper angle may risk impacting the top cover or actuating surface of the mine, which in the case of the anti-personnel mine might cause it to detonate. Mines can also rotate in the ground due to soil movement, so that the top face of the mine can end up being hit by the prodder. In the same way, mines in the 'windrow' of soil produced by a mine plough can be at any orientation, which makes detection by prodding potentially hazardous.

Based on an analysis of available data, the clearance method most likely to involve an accident to the deminer performing it is prodding from the surface of the ground. Despite these shortcomings, the mine prodder is likely to remain a useful tool for the mine and munition clearer for many years to come, although it is often being replaced by manual excavation using a small trowel or spade. This is generally regarded as being faster and safer.

It is fairly straightforward to train manual demining teams and highly academically qualified personnel are generally not required. Where labour costs are low, manual deminers can be very cost-effective. Manual mine clearance is especially suitable when the clearance task at hand is of a minefield in which mines have been laid according to military standards, marked and fenced. Thick vegetation or clearance of urban areas will significantly slow manual deminers, so the other demining options may have to be considered.

A GICHD sub-study on the management of manual mine clearance, published in 2005, concluded that the main areas for improvement were not at the individual deminer level, but at middle and senior management levels, where a significant waste of time and resources was observed. These include the management of minefield clearance sites and the decision-making associated with designated areas for clearance.

Mine detection animals

Animals have a keen sense of smell. Their powers of scent detection exceed that of humans by many orders of magnitude. A human may be able to detect one part of contaminant in ten thousand (1 in 10^{-4}), and some gas chromatographs may be able to detect down to one part in one thousand billion (1 in 10^{-12}) but dogs and rats are estimated to be able to detect to 1 in 10^{-15} or less.

The animal most commonly used for mine detection is the dog, mainly because of its ability to work in conjunction with humans. Rats have, however,

also been trained for humanitarian demining but have been deployed in only one country so far. Dogs and rats can be trained to detect odours from specific vapours, specifically the explosive contents of landmines. Dogs have been used for tracking and hunting for centuries, and for the detection of landmines since the 1939–1945 War. Animals indicate the presence of a mine to their handler, who will then pass on responsibility for clearance to a deminer.

Animal detection can be applied in many different demining roles. Animals can also detect mines with a low metal content and mines buried in areas with a high metal contamination or background. Dogs and rats can therefore be extremely useful for mine detection. For that reason, mine dog detection has rapidly become the second most common mine clearance approach, and today more than 25 organisations use mine detection dogs (MDDs) worldwide.

Animal detection can be faster and more cost-effective than manual demining if implemented correctly and improvements of between 200 and 700 per cent have been quoted, depending on environmental conditions, type of tasks and operational concept of each organisation. Dogs are at their best when indicating individual mines or minefield boundaries, rather than concentrations of mines. As such they are best for activities such as the following:

- area reduction and delineation of minefield boundaries;
- mine and ERW verification;
- clearance of roads and road verges;
- clearance verification, including the rapid sampling of cleared areas, which can be done behind both manual and mechanical demining;
- battle area clearance verification;
- the elimination of pockets of land unreachable to mechanical clearance devices;
- clearance of railways and sites with heavy metal contamination; and
- creation of safe lanes for clearance start points.

On the other hand, since dogs have very specific uses in demining operations they demand long training and qualified personnel. It can be a some time before an effective – and efficient – MDD capacity is established in a mine or ERW-affected country. In a dense minefield, or in areas of thick vegetation, dogs will be less effective than manual deminers. And in hot weather, the working time of dogs will be limited. Although dogs cannot replace manual deminers, they can be a powerful tool when used in combination with manual and mechanical clearance, and can often have a large potential within demining operations.

Dogs and rats can also be used in a system called Remote Explosive Scent Tracing (REST). The basic principle of REST is to collect dust or air samples from mine suspected areas or along roads in filters, which are later presented to specially trained animals for analysis. If a filter is presented to several animals in succession and none of them indicate the presence of mine or other ERW, the sector from which the sample was taken will no longer be classified as suspect. On roads, this can typically amount to 90 per cent of the road length.

Mine Detection Dog | Angola

REST has been used by a few organisations for more than ten years and mainly for road verification. While often forgotten when discussing demining because so few demining organisations use REST, it remains a fact that REST is responsible for a major part of all worldwide road mine verification. The UN has relied on the use of REST in support of many of their mine action programmes, in countries like Afghanistan, Angola, Mozambique, and Sudan. One reason why REST is limited to a few organisations may be that the system is complex and it is difficult to prove the quality of the process. REST is sometimes also referred to as Mechem Explosive and Drug Detection System (MEDDS) after the organisation that first pioneered the system.

Mechanical demining

Machines have not been fully accepted among deminers as a tool of equal reliability for full clearance to the two mainstays of clearance methodology: manual deminers and MDD teams. Nonetheless, an increasing number of mechanical devices have been produced to detonate, destroy or isolate mines. Early machines were often unwieldy, unreliable and under-powered, and the clearance achieved fell below the minimum UN requirement, unless they were part of an integrated manual-mechanical procedure. At present, where such machines are used, their operation is usually confined to the reduction of risk by the removal of vegetation and tripwire-operated mines, and some mine destruction as part of area reduction.

In early 2004, the GICHD published a study of mechanical mine clearance equipment, looking at its efficiency, productivity and cost-effectiveness.[12] It concluded that, given suitable conditions, machines can be used as the primary clearance system. This conclusion was based on a careful examination of clearance data of certain machines used for ground preparation; this data showed that after the passage of machines manual deminers and MDD teams found no live items of ordnance in areas known to have previously contained them.

Deminers who use mechanical systems have a good idea as to the most appropriate environments in which their machines might achieve clearance to humanitarian standards, but national demining authorities are still reluctant to accept that machines form the primary clearance method. The lack of precedents creates a lack of confidence.

An exception to the general reticence to apply machines as the primary clearance method is mechanical excavation with converted commercial earth-movers. These machines remove potentially contaminated soil down to a depth suggested by survey information. It is undisputed that areas treated in this way are free of ordnance down to the depth excavated. This technique represents the only current example of machines being employed as the primary clearance tool, but the practice is not widespread because it is slower than other mechanical systems and may cause serious erosion in some areas.

In sum, under the right circumstances, machines can be extremely cost-effective components in a demining programme and are particularly useful not only for area reduction and verification of clearance, but also as a primary clearance method. There must, though, be appropriate infrastructure (roads and bridges) and the availability of spare parts and low-loaders to transport heavy mechanical equipment will influence any decision to use machines. In general, machine clearance, is not appropriate for mountainous terrain. Finally, anti-tank mines and large items of explosive ordnance will damage or even destroy all but the heaviest and best-protected demining machines, so it is essential during suveys to identify the type of ordnance to be encountered in clearance operations.

OTHER DEMINING TECHNOLOGIES

In addition to the three main tools in the demining toolkit, there are a number of other demining technologies being used, researched or under development. For more details of the status of specific technologies and systems, see GICHD's *Guidebook on Detection Technologies and Systems for Humanitarian Demining.*[13]

Light flail machines | Azerbaijan

Ground penetrating radar

Ground Penetrating Radar (GPR)[14] has come into use over the last 20 years in civil engineering, geology and archaeology, for the detection of buried objects and soil study. The detection of buried landmines has also been a subject of considerable interest, in particular due to radar's potential for the detection of plastic-cased mines which contain little or no metal. Today, a large number of organisations are working on different parts of GPR systems, and – among all the sensors proposed for demining – GPR has had by far the greatest research funding and effort dedicated to it.

Ground penetrating radar (GPR) consists of a transmitter, which sends a pulse of energy or a continuous wave at certain given range of frequencies and is matched to a receiver, which takes in the reflected radar signals. The radar energy passes through the ground and is reflected back, at different speeds, depending on the material through which the radar energy is passing. GPR systems usually operate in the microwave region, from several hundred MHz to several GHz.[15] If the radar detects a sub-ground object of a different material,[16] the object can be detected. This means that plastic or totally non-metallic objects can be detected by GPR.

What particularly matters for the detection of objects in a background medium, e.g. mines buried in soil, is the difference between the electromagnetic properties of the target (in particular its dielectric constant) and those of the background (the GPR works as a target-soil electrical contrast sensor). The amount of energy reflected, upon which reliable detection is based, also depends on the object's size and form. Spatial resolution[17] depends on the frequency used, and the resolution needed to cope with the smaller anti-personnel landmines requires the use of high frequency bands (up to a few GHz). These higher frequencies are, however, particularly limited in penetration depth.

Unfortunately, despite being the most likely technology to be fielded by the end of the 1990s, GPR detectors are only just becoming available for the use in the field. The problems surrounding their development have been more difficult than was originally thought. GPR has proven to have too many limitations to offer an advantage when used in isolation. However, three systems combining GPR with metal detection (in one handheld unit) have now been developed and deployed in some programmes. Field tests have shown that if the GPR is used as a confirmation tool when the metal detector is giving a reading, the number of false alarms from the metal detector can be significantly reduced, which will speed up the manual mine clearance process. Despite the significant improvements already achieved, combined metal/GPR detectors have not yet found a significant market in the humanitarian mine clearance scene, largely due to the costs involved.

Detecting explosive vapours

Another way of detecting mines is by detecting their smell. There are two ways in which explosive vapour can be detected: first by taking the detector to the source of the scent, and second by taking the scent to the detector. There are currently two main methods under development for detecting explosive vapours: chemical sensors, and animals or insects.

Chemical analysis detectors

There are a number of chemical analysis techniques in existence but the method showing the greatest practicability and resolution is that of gas chromatography. In this method, a sample in the form of gas or liquid is moved by a carrier gas along a column containing on its inner surfaces a chemical liquid in a solid supporting structure. The various components of the sample interact with the chemical liquid. The components of the sample are detected when they emerge from the column. The time they have taken to move down the column varies according to their chemical nature, thus discriminating between them and identifying them. The components are then detected in a way that measures their relative quantity, so the final readout can separate the sample's component parts and identify its chemical composition and quantity.

Most gas chromatographs are more suited for laboratory use than field use, as they are large, delicate and require reliable supplies of electricity and gases. They could be built into a mobile laboratory, which then could be taken into the field where vapour samples could be brought for analysis, requiring use of remote explosive scent tracing or mine detection dogs.

Animal detection

The Belgian APOPO project has looked into the use of rats for explosive detection. Early experience with African pouched rats showed that they could be sociable, easily trained, and that their ability to detect specific odours was possibly as good as, or better than, that of the dog. The APOPO project is still ongoing in Tanzania and Mozambique, and the results are encouraging. Rats can breed quickly and successive generations become increasingly tolerant to humans and easier to train. Basic training can be carried out in small multi-choice cages (Skinner boxes) and results can be collected directly by computer, so that identifying the better rats becomes a quick and effective process. Experiments have also been carried out with insects such as flies or bees. While the insects may be bred to have excellent detection capability and sensitivity, how they can be used repeatedly in the field has not yet been specified.

QUALITY MANAGEMENT OF MINE CLEARANCE OPERATIONS

Whatever method is used to detect and clear mines and ERW, the quality of clearance must be effectively assured. According to the IMAS, this is done through a two-stage approach. Stage 1 quality assurance (QA) involves the accreditation and monitoring of the demining organisation before and during the clearance process. To achieve this, demining organisations need to establish an effective management organisation, develop and maintain procedures, and apply these procedures in a safe, effective and efficient manner. The purpose of QA in demining is to confirm that management practices and operational procedures for demining are appropriate, are being applied, and will achieve the stated requirement in a safe, effective and efficient manner. Internal QA will be conducted by demining organisations themselves, but external inspections by an external monitoring body should also be conducted.

Stage 2 quality control (QC) involves the process of an inspection of cleared land before it is formally released to the beneficiaries for use. It is intended to provide additional confidence that the land is free of explosive contamination, for example through sampling of part of the demined area using manual deminers, MDDs or machines.

This combined application of quality assurance (before and during the clearance process) with post-clearance quality control will contribute to achieving an acceptable level of confidence that the land is safe for its intended use. The quality of clearance must be acceptable to both the national mine action authority and the local community that benefits, and needs to be measurable and verifiable.

Handover of cleared land

Once land has been cleared of all mines and other ERW, there is usually an urgent need to make it available for productive use without delay. In some cases the local population will occupy land immediately following clearance in order to confirm ownership by re-establishing historic land rights. Also, at the end of a project, the demining organisation will be keen to re-deploy its demining teams to new sites requiring urgent clearance.

Despite the pressure to move on, a number of important issues must be addressed and tasks completed before the land can be considered formally 'cleared' and available for use. In particular, all post-clearance inspections should be completed and any corrective action carried out; permanent survey markers should be emplaced and accurately recorded for future reference; and all necessary information (such as monitoring and inspection reports) should be collated and made available for the formal handover. The demining organisation or its nominated community liaison representative *(see the following chapter on mine risk education for details of community liaison)* must ensure that the mine-affected community is fully aware of all demining activities in the area and the implications for the community.

EXPLOSIVE ORDNANCE DISPOSAL AND BATTLE AREA CLEARANCE

Explosive ordnance disposal (EOD) operations involve the detection, identification, field evaluation, render-safe, recovery and disposal of explosive ordnance. EOD may be undertaken as a routine part of mine clearance operations following the discovery of UXO in or near mined areas. EOD operations may also be undertaken to dispose of UXO discovered outside mined areas. Such operations may involve a single item of UXO or a number of items of UXO at a specified location, such as a mortar or artillery gun position. It may also involve a stockpile of ammunition left in a bunker or an ammunition point – abandoned explosive ordnance (AXO).

Battle area clearance (BAC) is the systematic and controlled clearance of explosive remnants of war from hazardous areas in a former combat zone where the threat is known not to contain mines. Most ERW found during demining are small items, such as submunitions, grenades and mortar ammunition which have been fired but have not exploded. These are often cleared by ordinary deminers. Nevertheless, UXO also includes larger items such as artillery ammunition, guided missiles and air-dropped bombs. The wide variety of size and complexity of UXO requires that special attention be given to the management of EOD and BAC.

To a certain extent in the past, the problem of UXO has not received the international attention it deserves based on its impact on the civilian population. Urban and peri-urban contamination tends to be of UXO rather than mines and some 'mine'-affected countries, such as Laos or Viet Nam are actually plagued by huge UXO contamination and face little or no humanitarian threat from landmines. The international community has now begun to address with greater seriousness the problems caused by these 'explosive remnants of war' (ERW), as is evidenced by the adoption and entry into force of Protocol V to the CCW.

In seeking to clear UXO, it must be borne in mind that there are many more types of munitions and fuzing used in explosive ordnance than is the case with landmines. So, whereas a deminer can be trained in a month, becoming an expert in EOD takes years. EOD is extremely painstaking work. Thus, the first task for an EOD technician faced with an item of UXO is to identify its fuzing system and decide whether it is safe to handle. Some stored ammunition may be already fused and stockpiles may also be booby-trapped. Checking this takes time, balancing safety and speed.

According to IMAS, UXO should normally be destroyed *in situ* by detonation. If this is not possible or appropriate for reasons of safety or for local environmental considerations such as the proximity of buildings or facilities, demining organisations must render a munition safe by neutralisation and/or disarming prior to moving it to a suitable location for disposal.[18]

The legal framework

Although mine action seeks to clear all mine and other ERW hazards, significant international attention has focused on the clearance of emplaced anti-personnel mines since the late 1980s and early 1990s. This has galvanised the attention of many countries as a result of the entry into force of the Anti-Personnel Mine Ban Convention. Under the Convention, each State Party undertakes to destroy or ensure the destruction of all anti-personnel mines in mined areas under its jurisdiction or control, as soon as possible but not later than 10 years after a State becomes party to the Convention.[19]

The reference to "ensuring the destruction of" emplaced anti-personnel mines confirms that a State Party is not obliged to carry out the requisite clearance itself, but may have recourse to external assistance, not only from other governments but also from NGOs and commercial companies. Similarly, the IMAS clarifies that demining may be carried out by different types of organisations, such as NGOs, commercial companies, national mine action teams or military units, and may be emergency-based or developmental.[20]

To assist in the implementation of the clearance obligation, States Parties to the Anti-Personnel Mine Ban Convention "in a position to do so" (the term is not defined) are obliged to provide assistance for the destruction of emplaced anti-personnel mines.[21] Assistance may be provided, inter alia, through the UN system, international or regional organisations or institutions, NGOs, or on a bilateral basis. Many States (not only those that are party to the Convention) have already provided financial, material and technical assistance and training for humanitarian demining.[22]

States Parties must also facilitate the fullest possible exchange of equipment, material, scientific and technological information concerning the implementation of the Anti-Personnel Mine Ban Convention. 'Undue' restrictions must not be imposed on the provision of mine clearance equipment and related technological information for humanitarian purposes.[23]

Of course, some States, especially those severely affected by mine and other ERW contamination, may not be in a position to complete the necessary clearance operations within the ten-year deadline. For this reason, each State Party may submit a request to a Meeting of the States Parties or a Review Conference for an extension of the deadline for completing the destruction of emplaced anti-personnel mines, for a period of up to 10 years.[24] A State may apply for further extension periods.[25]

In support of the clearance operations, each State Party is also required to make *"every effort to identify all areas under its jurisdiction or control in which anti-personnel mines are known or suspected to be emplaced"*. They must also ensure *"as soon as possible"* that the mines are perimeter-marked, monitored and protected by fencing or other means, to ensure the effective exclusion of civilians until the clearance operations are complete.[26]

In addition, Amended Protocol II to the Convention on Certain Conventional Weapons requires that *"all reasonable precautions should be taken to protect civilians from the impact of mines, booby-traps and other devices"*.[27] The location of all mines, booby-traps and other devices must be mapped and recorded in all circumstances in accordance with the provisions of the Technical Annex to the Protocol.[28] In addition, manually-emplaced anti-personnel mines that are not self-destructing and self-deactivating can only be used if they are *"placed within a perimeter-marked area which is monitored by military personnel and protected by fencing or other means, to ensure the effective exclusion of civilians from the area. The marking must be of a distinct and durable character and must at least be visible to a person who is about to enter the perimeter-marked area"*.[29]

In practice, these requirements are seldom met. Few mined areas are fenced, and few accurate minefield maps have been made available. Perimeter fencing has often been removed by local people for their own purposes, or destroyed by animals or natural causes. In 2006, the GICHD conducted a study of marking and fencing of mined and ERW-affected areas. The study found a wide variety of practices across affected States.

DEMINING

On 28 November 2003, States Parties to the 1980 Convention adopted a new protocol – Protocol V – to address the serious post-conflict humanitarian problems caused by explosive remnants of war other than landmines. It allocates responsibilities for the clearance, removal or destruction of such ERW,[30] defined as *"unexploded ordnance and abandoned explosive ordnance"*,[31] and calls for *"all feasible precautions"* to protect civilians from their risks and effects.[32] In addition, States Parties *"in a position to do so"* must provide assistance for the *"marking and clearance, removal or destruction"* of explosive remnants of war.[33] The Protocol entered into force on 12 November 2006.

ENDNOTES

1 IMAS 04.10, Second Edition, 1 January 2003 (incorporating amendment numbers 1 and 2), Definition 3.51.

2 Demining should be distinguished from military mine clearance, as the objective of demining is to clear all of the mines and other explosive remnants of war from a given area to return safe land to the civilian population. For soldiers in battle, on the other hand, speed is essential, and they must accept greater risks. Therefore, military breaching may clear only a path through a minefield and may not destroy every single mine in the path of armed forces.

3 The term humanitarian demining is a synonym of demining, but is considered less appropriate by some because demining may be conducted for other than merely humanitarian purposes.

4 For the purposes of the IMAS an 'assessment' is defined as "a continually refined process of information gathering and evaluation" whereas 'a survey' is a distinct operational task capable of being contracted. IMAS 08.10, Edition 2, 1 January 2003, p. v.

5 IMAS 04.10, Second Edition, 1 January 2003 (incorporating amendment numbers 1 and 2), Definition 3.93.

6 IMAS 04.10, Second Edition, 1 January 2003 (incorporating amendment numbers 1 and 2), Definition 3.249.

7 See for instance the mine action overview in International Campaign to Ban Landmines, Landmine Monitor Report 2006: Toward a Mine-Free World, Mines Action Canada, Ottawa, July 2006.

8 IMAS 01.10, Second Edition, 1 January 2003, p. 1.

9 GICHD, A Study of Manual Mine Clearance, Section 1: History, Summary and Conclusions of a Study of Manual Mine Clearance, Geneva, August 2005, p. 30.

10 GICHD, A Study of Manual Mine Clearance, Section 1: History, Summary and Conclusions of a Study of Manual Mine Clearance, Geneva, August 2005, p. 11.

11 GICHD, Mine Action Equipment: Study of Global Operational Needs, Geneva, 2003.

12 GICHD, A Study of Mechanical Application in Demining, Geneva, January 2004, p. 3.

13 GICHD, Guidebook on Detection Technologies and Systems for Humanitarian Demining, Geneva, March 2006.

ENDNOTES

[14] This section is based on P. Blagden, "Landmine detection and destruction technologies", Chapter 2 of Mine Action: Lessons and Challenges, GICHD, Geneva, October 2005; and GICHD, Guidebook on Detection Technologies and Systems for Humanitarian Demining, Geneva, March 2006, p. 17.

[15] The upper frequency band corresponds roughly to that of cellular phones/microwave ovens.

[16] Or, more strictly, material of a different permittivity or dielectric constant.

[17] The capability to distinguish two closely spaced objects and/or to define the shape of an object. Increased spatial resolution leads to sharper "pictures", whether real ones in the case of an imaging sensor, or "virtual" ones in the case where an operator interprets a sensor's output — in demining, typically an acoustic signal — and builds a mental map of it.

[18] IMAS 09.30, Edition 1, 1 October 2001, incorporating amendment numbers 1 & 2, p. iv.

[19] Article 5, Anti-Personnel Mine Ban Convention.

[20] IMAS 04.10, Edition 2, 1 January 2003, Standard 3.42.

[21] Article 6, paragraph 4, Anti-Personnel Mine Ban Convention.

[22] For details, see for instance the overview on funding as well as individual country reports in International Campaign to Ban Landmines, Landmine Monitor Report 2006: Toward a Mine-Free World, Mines Action Canada, Ottawa, July 2006. Information is also available on the UN's Electronic Mine Information Network (E-MINE), at **www.mineaction.org**.

[23] Article 6, paragraph 2, Anti-Personnel Mine Ban Convention.

[24] Article 5, paragraph 3, Anti-Personnel Mine Ban Convention.

[25] Article 5, paragraph 5, Anti-Personnel Mine Ban Convention.

[26] Article 5, paragraph 2, Anti-Personnel Mine Ban Convention.

[27] Article 3, paragraph 10, Amended Protocol II.

[28] Article 9, paragraph 1, Amended Protocol II.

[29] Article 5, paragraph 2, Amended Protocol II.

[30] Article 2, paragraphs 1 to 4, Protocol V to the CCW. The text of the Protocol is included in Appendix 4.

[31] See Article 3, Protocol V.

[32] Article 5, Protocol V.

[33] Article 8, paragraph 1, Protocol V.