LAND RELEASE
KEY MESSAGES

• Land Release is a process that includes non-technical survey (NTS), technical survey (TS) and clearance activities; it is at the heart of addressing the real and perceived threat of landmines, cluster munitions and other explosive remnant of war (ERW).

• Efficient land release is achieved by promoting less expensive survey above more expensive clearance activities and avoiding default clearance of entire suspected hazardous areas (SHAs) or confirmed hazardous areas (CHAs), where feasible.

• Greatest advances in land release efficiency are made through improved NTS techniques using suitably qualified staff.

• Survey and clearance of areas contaminated with submunitions can be undertaken much faster than areas suspected of containing mines.

• Residual contamination from mines/ERW will remain a long term management issue in many countries that have suffered intensive conflict.

• Manual deminers provide the most confident clearance method but are slow and often the most expensive.

• Animal detection systems (ADS) can be used in areas where mines with low metal content are anticipated because they detect odours from explosives rather than rely on detecting the metal in mines.

• Mechanical systems can be highly cost-effective components in a demining programme.

• Demining is generally arranged through contracting and competitive grants whose terms and frame have considerable implications on operational efficiency.

INTRODUCTION

The removal and destruction of landmines and ERW is a relatively straightforward activity once their location has been identified. The main challenge in mine action operations lies in defining their precise locations, and, when the boundaries of contamination remain unclear, on deciding where to start and stop clearance.

The term ‘overclearance’ has been used by some to describe excessive operations in mine action, when land that does not require clearance is cleared (and funds wasted) during the process of removing the real and perceived threats posed by landmines or ERW.
Such operations result in a low yield of ordnance in relation to the area searched. In some cases large tracts of land have been cleared without finding any evidence of landmines or ERW. While sometimes clearing extensive areas without any clear identifiable threat remains a necessity (in response to emergency or developmental imperatives), there are many cases where significant improvements in targeting operational assets can be made.

Land release is the process that brings together non-technical and technical activity, in conjunction with information management. This allows effective, efficient and reliable decision-making about which land requires attention, which does not, and how best to deploy precious, expensive technical assets.

By definition, the land release process encapsulates survey approaches as well as clearance activities. Land can be released through survey and through clearance. However, the impetus behind the land release agenda is to provide a clearer balance in favour of less expensive and quicker survey activities, as opposed to more expensive and slower clearance procedures.

Land release promotes a system of escalating survey activities, and only resorts to full clearance as a last option. Each effort in the land release process seeks to define more accurately where contamination is to be found (and where it isn’t) so that clearance activity takes place only where it is needed.
Efficient land release is achieved by thorough information gathering techniques, with analysis of historical data, non-technical survey data, information from other operations at similar sites, good evidence-based planning for the deployment of technical survey and clearance assets, and appropriate adjustments to plans when operations are underway.

The extent to which survey activities, particularly technical approaches, can limit the need for extensive clearance depends to a large extent on the nature of the expected contamination and the availability of information about it.

Efficient land release typically depends on two related factors:

1. How easy or difficult it is to define the extent of contamination.
2. How good mine action agencies are at achieving that definition.

The first factor depends to a great extent on the nature of the contamination, whether it exhibits regular or irregular features and the availability of records. The second factor depends on the competence of its people, the processes and procedures it uses, and the extent to which it makes good use of information management systems.

**NATURE OF CONTAMINATION**

The extent, characteristics and distribution of mine and ERW contamination varies widely between countries, regions and individual sites. This depends on the history of the conflict, the types of weaponry used and a range of environmental influences.

**Mine laying strategies**

Landmines have been widely used to destroy, delay, disrupt and channel enemy forces. Mine laying strategies and the distribution of mines vary greatly, depending on the context of the conflict, the tactical aims of the warring parties, and the availability of mines. The way mines are distributed, and the extent to which they can be readily detected using electronic or other means, is directly relevant to the efficiency with which the land release process can be applied.

It should be easier to target technical activity and minimise land release costs if mine laying has been more regular and predictable. The more irregular, widely dispersed and unrecorded mine laying is affects how difficult it is to identify which land is safe and which is not, and the more time and cost are likely to be associated
with land release activities. It is important for implementing organisations to understand the context of mine laying and the history of conflict in the area in order to conduct efficient survey and clearance of minefields.

Most mines are laid by hand but there are also technical systems allowing mines to be laid mechanically and to be scattered by artillery or from the air by plane or helicopter. Conventional minefields laid by trained military forces are normally patterned, mapped and marked on the ground. Such minefields are typically laid to protect static installations such as military bases, borders, towns and strategic positions such as bridges, electricity pylons and dams.

In many cases minefield records, if originally available, are later lost or destroyed. Even when records are no longer available patterned minefields offer good opportunities for the efficient application of technical survey techniques and for confident decision-making about when technical work should stop.

A lack of records is more common in situations where mines have been laid in haste, when the mines may also have been laid in an irregular and hard-to-predict manner. In some cases mines may have been recovered by the unit that laid them, in others such recovery may have been prevented by the presence of opposition forces. During conflicts front lines often shift back and forth, resulting in successive, overlapping layers of mines, adding to the difficulties of definition and predication.
The situation becomes even harder to understand when minefields are laid in a deliberately sporadic fashion, to disrupt the activities of the opposition and the population at large. This tactic is used most commonly during guerrilla warfare when insurgent groups operate with limited access to mines.

As time passes even the most predictable minefields can become harder to understand. Human and animal accidents, and the burning of vegetation, may lead to the detonation of some mines leaving gaps in patterns, making it difficult to take confident decisions about when all mines have been cleared and it is appropriate to stop work.

Both erosion and flooding can lead to mines moving, becoming more deeply buried or being brought closer to the surface. Patterns can be disrupted by undocumented clearance activity that covers only parts of the mined area, or clearance activity that missed mines, and does not conform to national and international standards. Efficient land release decision-making is made harder by any factors that make it more difficult to define where mines are and where they are not. This tends to lead towards additional technical work.

**Cluster Munitions Remnants**

Cluster munitions are distinct from other munitions. When they are fired, launched or dropped, the explosive submunitions are dispersed, creating a strike pattern or ‘footprint’ on the ground. It is normal to find unexploded submunitions within the area of the footprint because of their high failure rate.¹
By recognising the shape of a footprint, and identifying its centre and outer edges, it is often possible to determine where technical activity is necessary, and where it is not. Predictability always helps efficient land release decision-making, and where cluster munitions strikes are relatively recent there are likely to be opportunities to apply efficient processes. As time goes on, though, the situation may become less clear.

Environmental effects (flooding, erosion, landslides and the encroachment of vegetation) make it harder to see indicators of the presence of submunitions and to detect those that are present. Members of the local population may move items, creating apparent evidence of contamination in areas that weren’t originally subject to attack.

In areas where mines are not present a different survey and clearance methodology can be adopted when addressing submunitions contamination. The significantly higher metal content in submunitions makes them easier to detect. While areas suspected of mine contamination cannot be entered, areas containing submunitions alone can be entered, investigated and cleared of vegetation before clearance allowing faster and more efficient operations.

**Other Explosive Remnants of War**

Landmines and cluster munitions, however, attract particular attention as a result of their ban under international conventions. Other types of ERW are often more prevalent in post-conflict settings – mortars, artillery shells and air-delivered bombs that failed to detonate as intended. These generally do not create a predictable pattern after being fired or delivered although they may be concentrated in certain areas.

Lao PDR and Vietnam are examples of nations affected predominantly by UXO with a broad range of ERW (including considerable submunition contamination), but without widespread mine contamination. Such UXO also have an impact on public safety and on socio-economic development often contributing to a complicated 3-dimensional spread of contamination.

These problems typically require management over many years and decades. Mines and submunitions contribute to surface and shallow surface contamination, but the greater kinetic energy of mortars, artillery shells and particularly high altitude bombs results in many deeply buried items, often several metres deep. In Vietnam and Lao PDR bombs are frequently found at depths between one and five meters with some heavy ordnance being recorded at depths of 10 to 20 meters.
FIGURE 7
ANNUAL TONNAGE (KG) OF UXO DISPOSED OF IN BERLIN 1947–2011

Source: Record of finds and responses by EOD unit of West-Berlin (later Berlin) police ‘PTU’.
Similarly, during World War II, many parts of Western Europe suffered intense bombardment from the air and ground, leaving huge quantities of unexploded ordnance in cities, the countryside, rivers, lakes and seas. Much can be learnt that is relevant for other countries with more recent conflicts, such as those in South East Asia.

**Combinations of contamination**

A combination of regular minefields mixed with widespread low density and irregular mine distribution spread over a large geographic area can be found. Furthermore, additional ERW contamination including submunitions can be superimposed onto the mine hazardous areas. Where aerial bombardment has also contributed deep buried UXO the operational environment and nature of the contamination can be highly complex.

Combinations of contamination types require combinations of land release responses, and rely even more upon high standards of data collection, analysis and use. Technical survey in areas suspected of containing cluster bombs or general ERW can proceed much more quickly than when there is a risk of the presence of landmines.

Mines become the dominant risk factor, imposing slow but safe area investigation and clearance techniques if they are suspected. To avoid slowing down all other ERW-related activities, it is common to address the landmine hazard first, before applying speedier UXO search techniques to the ground afterwards.

**LAND RELEASE PROCESS AND REPORTING**

Land release describes the process of:

- applying all reasonable effort towards the identification of hazardous areas;
- cancellation of land through non-technical survey;
- reduction of land through technical survey; and
- clearance of land from actual mine/ERW contamination.
All reasonable effort

Generally, ‘all reasonable effort’ is considered to have been applied when:

- It can be shown with justifiable confidence that mines/ERW are either not present in an area or, if they were found to be present, have all been destroyed or removed from that area.
- The commitment of additional resources is considered to be unreasonable in relation to the results expected.4

Diagram illustrating the two land classifications: confirmed and suspected hazardous areas and the three activities that can contribute to their release: non-technical survey, technical survey and clearance. The three products of these activities are cancelled, reduced and cleared land respectively. Reporting at a national level, to donors and under IHL should conform to such terminology and land release statistics should be disaggregated.
The application of all reasonable effort applies to all stages in the land release process. It does not only mean making physical efforts to investigate ground, but includes appropriate use of data collection, analysis and information management to support and justify decision-making.

**Defining hazardous areas**

Land release involves defining where mines and ERW are believed to be, and then applying additional effort (technical and non-technical) to improve that definition until there is confidence that hazards are either not present, or have all been cleared. At the end of the process all released land should satisfy the basic requirement that it contains no hazards (to depth and size definitions) and is safe to use.

The area may be classified as either a suspected hazardous area (SHA) or a confirmed hazardous area (CHA) respectively. This depends on whether evidence of hazards is ‘indirect’ (eg unused agricultural land, verbal reports from the local population or former combatants) or ‘direct’ (eg accidents, reliable mine/ERW records, observation of mines in place, warning signs, etc.).

If the NTS finds that there is insufficient evidence of contamination in some or all of an existing SHA, land is released and considered to be ‘cancelled’. If TS finds insufficient evidence of contamination, land is released and considered to be ‘reduced’.

When NTS takes place in a new area and finds no evidence of the presence of mines or other ERW the area is not recorded as ‘cancelled’. Cancellation and reduction are only applied to areas that were previously categorised as suspected or confirmed hazardous areas (SHAs or CHAs).

IMAS 07.11 Land Release makes clear that, irrespective of the results of any survey or clearance operation, mine action operators should always record:

- what was done, where and when; and
- what was found, where and when.

Land release is a process of continual risk assessment, involving management of operations, people, information and quality. The ultimate goal is to free communities, districts and national territories from the effects of mine/ERW contamination.
SURVEY ACTIVITIES

The purpose of survey activities is to collect evidence to support efficient and reliable decision-making about where hazards are present and where they are not, to understand impacts upon populations and to support associated prioritisation and planning processes. All survey methods and techniques need to be appropriate to local circumstances and conditions, the nature of the contamination and the purposes for which data/information will be used. A combination of non-technical and technical means is generally used within the land release process.

NTS is usually the first step for both capturing new data on SHA & CHA and for releasing areas, or parts of areas, already held within databases (cancellation). NTS activities can be broadly grouped into two types:

1. Community-focused surveys
   - Impact Surveys, including the Landmine Impact Survey (LIS); and

2. Hazard-focused surveys
   - sometimes referred to as emergency surveys, General Surveys, Level 1 surveys but all grouped under the terminology of Non-technical Surveys according to IMAS.

TS, involving the deployment of technical assets into suspected areas, is used to gain direct information about the nature, extent and characteristics of contamination and the areas within which it is found.

Landmine Impact Surveys (LIS)

18 countries have conducted a national survey of the socio-economic impact of mines and ERW on communities using the LIS methodology. They followed a common set of protocols, a systematic approach to a national survey and standardised reporting and data entry into IMSMA.

The survey used three parameters – type of contamination (mines or UXO), land use, and number of victims – to generate an impact score for each surveyed community. This allowed communities to be ranked on the basis of their score and provided a framework to target resources during strategic planning and priority-setting processes.

Somewhat unfairly, the LIS methodology which focuses on measuring impact of mines/ERW on communities, rather than the specific location of mined areas,
has received some poor reaction for paying less attention to the accuracy of SHA boundaries. Misunderstandings led to some databases being populated with exaggerated sizes of hazardous areas.

A review by GICHD of LIS surveys in three countries demonstrated that the size of a SHA (in LIS terms an impact area, rather than a suspected hazardous area) created on the basis of LIS data can be reduced on average by approximately 90 per cent, if subjected to a further NTS. This statistic perhaps tells more about the extent of perceived impact around an area actually contaminated with mines, rather than necessarily indicating a poor quality of SHA definition during LIS. Lessons learned while addressing some of the misconceptions associated with the use of LIS data helped development of today’s land release methodologies.

**Non-technical Survey**

Non-technical survey (NTS) is the starting point for identifying, accessing, collecting, reporting and using information to define where mines/ERW are to be found, as well as where they are not, and to identify SHAs and CHAs where further investigation and/or clearance need to take place.

NTS methodology makes use of desk assessments, analysis of historical records, interviews with various informants, assessment of what was found during survey and clearance operations at other sites, and physical visits to field locations, typically without using technical equipment and without entering hazardous areas.

NTS field teams attempt to map known and suspected hazardous areas as accurately as possible. Additional information such as land use, land ownership and impact of reported hazardous areas including any victim data may also be collected.

While NTS is usually the starting point for operations, it can continue in parallel with TS and/or clearance activities throughout the land release process. New informants or information may emerge at any point providing additional evidence to adjust boundaries and further limit the extent of technical survey or clearance activities.

In spite of the highly varied nature of mine/ERW contamination, and the challenges faced when attempting to record the perimeters of suspect areas, the greatest advances in land release efficiency are achieved through more focused and enhanced NTS approaches. Too often the starting points for clearance tasks have been inappropriate and based on inaccurate or weak information that has not been scrutinised or strengthened before technical survey and/or clearance starts.
Technical Survey

Technical survey (TS) techniques involve a physical intervention, using survey or clearance assets into a hazardous area to:

- Confirm the presence, or absence, of mines/ERW and identify the type of hazards present.
- Better define the boundaries of a SHA/CHA that require clearance.
- Collect information to support land release decision-making.

Technical surveys can be broadly characterised into two main types:

1. Targeted investigations: specific areas or points within a hazardous area are preferentially targeted. These may be ‘high risk areas’ where accidents have occurred or where the presence of mines or UXO is considered most likely.

2. Systematic investigations: breaching or cut lanes are spread uniformly across an area, often ‘boxed’ with intervening areas left unprocessed. In some cases systematic investigations may expand to cover 100 percent of a suspected area.
Technical survey assets do not have to meet all the criteria of a clearance asset. What they must do is:

- Keep TS personnel safe.
- Provide a high probability (near certainty) that the presence of expected hazard items will be indicated by the equipment and methodology in use.

In practice it can be difficult to isolate TS as a separate activity within a linear/sequential process (ie, after NTS and before clearance). Activities are more frequently interlinked and may be carried out simultaneously. TS can occur:

- Before clearance to help delineate the SHA/CHA.
- During/in conjunction with clearance to inform decisions about the efficient conduct of a clearance task.
- After clearance, when investigation of a buffer zone around a cleared area may raise confidence that no mines/ERW have been left behind.

A Systematic Technical Survey (TS) using a flail. An 8 km long suspected hazardous area (SHA) was reported. Mechanical exploratory lanes were cleared every 25 m. No follow-up by another asset was required if no visual or audible detonations occurred during the mechanical operation. The ground between the lanes was left untouched. Nothing was found during operations and the entire area was released without any further action.


CLEARANCE

The most familiar and visible part of mine action is the clearance of mines and ERW. It is also the most expensive of the five pillars. Clearance refers to an intrusive information-gathering and threat removal process that fully defines a hazardous area whilst removing explosive hazards.

The aim of clearance is to create safe land by locating and then destroying all mines and other explosive hazards within a defined area to a specified depth. This requires management systems and clearance procedures that are appropriate and effective, safe and efficient. Besides conducting the clearance, demining organisations are expected to update nearby communities on the extent of any remaining threat and the progress of the operation. Community liaison is an important part of the demining process and an effective means of building confidence amongst key stakeholders, especially users of released land.

The term demining toolkit is frequently used in mine action, typically composed of three elements: manual clearance, animal detection systems and mechanical systems. The use of machines and animals has become common in demining operations, although the majority of landmines and ERW continue to be cleared manually.

The decision to select a particular combination of techniques in a country setting is influenced by the extent and type of threat which the munitions pose, as well as other important factors such as financing and security, infrastructure and terrain, and national laws.

Manual clearance

Manual mine clearance methods have not changed significantly since World War II. Techniques continue to rely on a deminer working along a marked lane using a metal detector, prodder, rake or an excavation kit until a suspicious object is encountered. Although these methods often mean relatively slow progress, they are widespread and popular in mine action programmes, in recognition of the very high levels of confidence associated with the land they release. Some organisations involved in manual clearance choose not to use alternative methods and assets.

Manual deminers are used to create and clear lanes and grid systems, performing targeted and systematic investigations as well as area clearance. Deminers are usually placed at a defined safety distance from each other, continuing clearance drills until discovering a suspicious object. The deminer then carefully excavates
around the object and, if it appears to be a mine or an item of explosive ordnance, it is either blown up in situ or defused and moved for destruction at the end of day.

It is uncomplicated to train teams of manual deminers and surveyors. In countries where labour costs are low, manual deminers can be cost-effective. They are well suited to clearing minefields for which laying records and maps are available, and where mines have been laid in rows or other identifiable patterns. Thick vegetation, rubble, debris, and urban areas are all factors that slow down manual clearance, prompting consideration of alternative means. Conversely, manual deminers can assist mechanical ground processing and clearance systems greatly in places with obstacles restricting machine access, and are used for community liaison tasks.

**Metal detectors**

In the 1960s the increasing use of plastics in mine manufacture decreased metal content sharply. In most modern anti-personnel mines, metal components are reduced to a few grams and include, at most, the firing pin, spring, and primer casing. To address the minimal metal content, modern detectors are sensitive and, compared to the cumbersome tools of the 1940s, they have become lighter, more durable, reliable and easy to use.

Unfortunately, as sensitivity has increased so has the susceptibility of metal detectors to signal false alarms from small metal fragments, and metallic compounds found in certain soils, such as laterite. Despite these limitations, metal detectors remain the most common means of detection and continue to undergo improvements in design.

Most modern detectors are built on the magnetic induction principle, able to compensate and filter out signals from unwanted metallic compounds in the soil. Some of them also feature ground penetrating radar (GPR). Despite enhancements in software and sensor technology, they are required to be durable and simple to use, easy to repair and recharge, with little need for maintenance.
Prodding

The prodder remains a common tool used to confirm the exact location of a buried mine. It is cheap, simple and effective and is used to feel the mine gently from its side as it lies in the ground. This is achieved by piercing the ground surface at a maximum angle of 30 degrees, to avoid disturbing the top of the mine, which is, in most types, the location of the triggering mechanism.

Prodders are made of many materials, from expensive plastics to steel, aluminium and iron. The disadvantages of prodding include the increased cost of more sophisticated designs, the close proximity of the deminer’s head and hands to the investigated mine and the effort required to use it in rocky terrain. Prodders are not used when there is a possibility of encountering mines with an anti-disturbance fuse, or that have rotated in their position.

Rakes

Rakes are used for excavation and mine detection in sandy beaches, deserts and other soft terrains without significant root systems, thick undergrowth or stones. The operating principle is either to approach the mine from the side as with a prodder, or to scoop and pull the mine from beneath: the former aims to pinpoint the exact location of the mine for follow-on excavation; the latter to lift the mine to the surface in one pull.

The rake offers the advantages of an increased distance between the deminer and the mine, faster clearance progress, low cost and the potential for local manufacture. In terrains littered with metal fragments, the raking method is considered significantly more efficient than the use of metal detectors. In sandy or otherwise suitable soft terrains, some demining operators have replaced metal detectors entirely with rakes.

The downside of the raking method is the rough approach to a mine, and the potential for unwanted explosions. The deminer is well protected and stands at rake shaft distance away from the seat of an explosion, so s/he is likely to avoid serious injury, but the blast, sound and catapulting earth fragments may still cause some injury. When applied with care, however, the rake remains a useful tool for mine clearance.

Excavation

Full excavation can deliver the highest level of confidence of all the manual clearance methods, but it is the most time-consuming. Removing all soil to
a specified depth is easy to supervise on site, but the technique is generally limited to:

- Areas on steep hill slopes or other places where it is difficult to move safely.
- Certain urban areas.
- Hard soil combined with high metal contamination.
- Areas with very low metal content mines that are unsuitable for mechanical or animal detection systems.

**Progress and efficiency**

Daily progress varies greatly depending on the method and technology used as well as the operating terrain, type of soil and current weather. Daily clearance output for one deminer has been observed between five and 150 m². Manual clearance is most effective and efficient when integrated with other detection and clearance methods.

While manual clearance procedures for individual deminers are regularly reviewed and assessed to identify opportunities to improve speed, safety and confidence, most observed inefficiency is found at team and operations management level. Lack of resource-sensitive planning and supervision, wrong priority-settings, too little attention to important study of time and motion, as well as weather, terrain and logistics variables, can all be significant.
The factor most influencing efficiency is that of confidence in taking land release decisions, either as a result of lack of relevant information, or because management structures do not authorise and equip managers at the right level of take decisions. As manual demining is labour intense and expensive, more emphasis is now placed on maximising outreach and accuracy of surveys preceding clearance, increasingly enabling decisions to deploy deminers only in areas that are actually contaminated.

**Animal detection systems**

The animal most commonly used for mine detection is the dog, owing to its proven ability to work with and be trained by humans. Rats are also used. They are trained to detect odours from specific vapours associated with the explosive or other components of mines and munitions. This is referred to as an animal detector system (ADS).

Dogs have been used for tracking for centuries and in demining since World War II. The animal indicates the presence of a mine to its handler, who then passes responsibility for investigation of the indication to a deminer.

Animals, like any other survey and demining asset, have some limitations, but experience shows that with good training, practice and planning, many of the weather and environmental limitations can be overcome.

Explosive detection animals can detect mines with a low metal content, deep buried AT mines and mines buried in areas with a high metal contamination
where the use of metal detectors would be difficult. ADS can be faster and more cost-effective than manual demining detector methods. Daily progress has been recorded from 300 m² to 2,000 m², depending on environmental conditions, the type of task and the operational concept in use. ADS are at their best when indicating individual mines or minefield boundaries, rather than trying to work within dense concentrations of mines.

Other recommended tasks include rapid sampling of areas already cleared by manual and mechanical demining, areas inaccessible for machines and approach routes to hazardous areas, as well as clearance of cluster munitions strikes and battle areas. Animals can be used with advantage in technical survey roles.

Animals, in particular dogs, have also been used in Remote Explosive Scent Tracing (REST). REST involves collecting dust or air samples in filters from mine-suspected areas and roads. The filters are then taken to a controlled environment where they are presented to specially trained animals for scent analysis. Samples are presented to several animals in succession. If none of them indicates the presence of mine or ERW scent, the area from which the sample was taken is no longer classified as hazardous.

REST has mostly been used for road verification, and has been applied for more than a decade in countries such as Afghanistan, Angola, Mozambique and Sudan. The majority of road verification work done around the world has used REST.

The main challenge with REST lies in the difficulty of quality assessing samples, ensuring that no cross-contamination has affected the filters during transport from the sampling area to the analysis area.

ADS cannot replace deminers, but is a powerful tool when used in combination with manual and mechanical systems, and can significantly increase productivity of a demining programme.

**Mechanical systems**

A variety of mechanical systems to detonate or destroy mines are manufactured to detonate or destroy mines. They can be highly cost-effective components in a demining programme, accelerating the progress of other assets, through removing vegetation and tripwires and breaking up soil. They can perform important functions in technical survey and, in some cases, can be used as a primary clearance method. The most common types of machines used in demining operations are equipped with flails, tillers and rollers.
Successful use of larger mechanical systems may impose demands on existing road and bridge infrastructure. All systems require the ready availability of spare parts and the tools and skills necessary to use them. The need for trailers and trucks to transport heavy mechanical equipment and the logistical support burden required to keep systems operating and serviced, often influences decisions about whether to use machines.

Anti-tank mines and large explosive munitions may damage or even destroy all but the heaviest and best protected demining machines. During preliminary surveys it is essential to identify the types of ordnance likely to be encountered to inform decisions about the use of machines.

Interest increased in the possibility of employing machines for humanitarian purposes as the modern mine action sector developed. Tremendous improvements have been made from the first mechanical system in 1942. Early machines were often cumbersome, unreliable and under-powered, and the achieved clearance results fell well below expectations (and the demands of modern humanitarian programmes).

Today a multitude of demining machines is available, equipped with reliable power trains, remote controls, navigation and positioning systems, and comprehensive service and support packages. Some machines are mass produced while others have been made in limited numbers or are one-off prototypes. In some cases agricultural and construction vehicles have been converted and armoured for mine clearance, offering savings for investment in terms of the availability and low cost for spare parts.

Mechanical systems conduct technical surveys, determine the boundaries of suspect hazardous areas, and play an important role in the overall land release process. Confidence in their use for clearance, under the right circumstances, has increased, as it has in their role as a risk reduction tool complementing the two mainstays of clearance methodology: manual deminers and mine detection dogs.

In 2004, the GICHD published a study of mechanical mine clearance equipment, examining factors influencing their efficiency, productivity and cost-effectiveness. The study concluded that in suitable conditions (threat type, soil and topography) machines can be used as a primary clearance system.

A decade later, confidence has increased and some mine action programmes use machines as a primary clearance system. The land release IMAS (07.11) emphasises the need to collect performance data during ongoing practical operations using machines, to build up a body of data on the basis of which
decisions can be taken about when and where it is appropriate to use machines in a primary clearance role.

Machines used in demining can be divided into those designed to:

- Detonate hazards
- Prepare the ground
- Detect hazards.

Some are designed to fulfil more than one of these purposes.

Many machines make use of human operators and are designed to protect their occupants and equipment from detonation effects. Others use remote-control systems to keep operators well away from the hazard.

Purpose-built systems include flails, tillers, vegetation cutting machines, sifters and other machines. Adapted systems can be fitted to front loaders and excavators, often armoured to enable clearance of explosive hazards either from within the hazardous area or from outside its boundary, reaching in.

Some mechanical systems serve simultaneous purposes. For instance, if a ground engaging tool is used as a flail during demining operations it may destroy mines, remove vegetation and loosen soil. If its prime mover is also fitted with a magnet it can remove metal debris and collect information on mine and ERW contamination.
Ground preparation machines can be used to increase the productivity and safety of mine clearance operations for other clearance assets. They may prepare areas for further clearance operations by cutting minor vegetation down to ground level and by destroying tripwires, or breaking ice and crust in cold conditions.

Suitable ground preparation machines may be used in the technical survey role to confirm whether a suspected area contains mines (usually be relying on the fact that any mines encountered will be detonated).

While there are numerous purpose-built machines and tools available for mechanical clearance, these are rarely able to defeat all mine types and are very unlikely to detonate all ERW. A systems approach is required, where machines with a combination of tools, a combination of machines with different tools, or manual demining and/or ADS procedures are applied at different stages of the demining operation.

One important factor when considering whether to deploy machines into an area is their impact on information and the extent to which decisions on when to stop technical work can be taken. In some cases, more cautious use of machines may be appropriate to preserve patterns of contamination. Balance between the use of a machine as a technical survey tool and as a clearance asset depends not just on the level of confidence associated with its clearance capabilities, but also on its ability to preserve and deliver, or disrupt and degrade, information.

**Other demining technologies**

Two notable new technologies are ground penetrating radar (GPR) and the detection of explosive vapours.

GPR consists of a transmitter that sends a pulse of energy (or a continuous wave at a certain range of frequencies) into the ground, matched with a receiver taking in the radar signals reflected from buried features or objects. The radar energy passes through the ground and is reflected back at different speeds depending on the material through which it passes.

GPR is particularly useful when built in to complement a traditional metal detector, enabling detection of plastic cased mines which contain little or no metal. Although the technology continues to be developed, GPR variations have been successfully used to improve productivity of deminers in minefields with high metal contamination, reducing the time wasted in excavation of false positive metal signals.
In explosive vapour detection two mainstream methodologies are currently under development – chemical sensors and insects. The method showing the greatest application and practicability is that of gas chromatography. Most gas chromatographs are more suited for laboratory than field use as they are large, delicate and require reliable supplies of electricity and gases. The system can be built into a mobile laboratory, which can then be transported into the field where vapour samples are brought for analysis, as with the remote explosive scent tracing (REST) described earlier.

Experiments in detection of explosive vapours have also been carried out with insects such as flies and bees. The insects can be bred to have excellent detection capability and sensitivity. However, ensuring that they can be made to return from the first task, to be used repeatedly in the field, is something which has not yet been established.

Other new technologies include expected improvements to protective equipment, on-going research in the use of handheld magnets, introduction of unmanned aerial vehicles (UAV) for surveys, and fitting magnets onto existing mechanical systems to reduce the amount of metal left behind them, speeding up manual clearance or verification procedures following their use.

**Battle area clearance**

Battle area clearance (BAC) is the systematic and controlled clearance of ERW from hazardous areas in a former combat zone where the threat is known to not 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 deminers. Unexploded ordnance refers to larger items such as artillery ammunition, guided missiles and air-dropped bombs. The complexity of UXO requires that special attention be given to the management of BAC and EOD.

BAC involves a surface search of a specified area by a team visually inspecting the ground for evidence of a hazard. It can also make use of procedures similar to those used in mine clearance locating items on and below the surface, in marked lanes. If both mines and ERW are present in the same area, the situation is first treated as a mine hazard, before addressing the ERW hazard using BAC techniques after the mine threat has been removed.

There are hundreds of types of UXO and fuzing mechanisms. Becoming an EOD technician requires years of practice. Once an EOD technician encounters an item
of UXO s/he identifies it and its fuzing system, possible booby traps, and then decides whether it is safe to handle. UXO is normally destroyed in situ. If that is not possible for safety reasons, or for environmental or infrastructure considerations, render safe procedures (RSPs) are applied to neutralise\(^6\) or disarm\(^7\) the item prior to moving it to another location for final disposal.

**Underwater EOD operations**

A number of States are affected by old naval mines, dumped ammunition and other ERW in harbours, territorial waters or inland waterways and lakes. A request has been proposed to develop an international standard and guide to best practices in underwater EOD operations. This process is now ongoing and once completed, it should contribute to the safety, quality and cost effectiveness of underwater surveys and clearance.

In addition to the humanitarian dimension, underwater munitions present a security risk and may be an impediment to development of infrastructure and economic growth. With exposure to water for prolonged periods, ammunition and ERW degrade and may become unstable. In time they release toxic substances, presenting a hazard to local livelihoods and infrastructure. Ammunition lying at shallow depths may also end up being used in Improvised Explosive Devices (IEDs).

As standards\(^8\) and guidelines\(^9\) already exist for military and commercial diving involving EOD, the forthcoming international underwater EOD standard will be
a normative reference and a central repository of guidelines for underwater EOD operations. There is potential to improve the effectiveness and cost-efficiency of the sector by mainstreaming mine action concepts and lessons learnt into underwater EOD operations.

LEGAL ASPECTS OF LAND RELEASE

Handover

The legal aspect of land release that is most familiar to operators and MACs arises when survey or clearance work is complete and land is ready to be handed over to its owners and/or users. A handover or completion certificate is usually used to bring as much clarity as possible to this important transaction. The certificate normally includes:

- Location, name and any other identifying details of the site.
- Details of the organisation that has carried out the land release work.
- A general description of what work has been done (survey, clearance, BAC etc.) and whether land has been released through cancellation, reduction, clearance or a combination.
- A statement explaining the condition of the land (including any depth or device type limitations associated with the task definition) and setting out any limits to the assurances provided by the land release operator.
- Name and dated signature of the authorised representative of the land release operator.
- A statement of what external QA and QC functions have been applied at the site, with an explanation of any assurances provided by the external QA/QC agency.
- Name and dated signature of the authorised representative of the quality assurance/control agency.
- Name and dated signature of the individual authorised to accept the released land on behalf of the government or other land owner.

Clear handover procedures and documentation are critical to confident and efficient release of land, and often play an important role in the contractual process associated with payment for work. Handover is an important threshold in the transfer of responsibility (and liability) for land between operator and owner and is often referenced in paperwork relating to an operator’s insurance.
**Contracting**

Globally the main legal mechanism for carrying out demining is through contracting. A contract is normally a time-limited agreement between a contracting agency and a contractor for provision of certain services and/or equipment. There are three main parties whose interests are fundamental to any contract:

1. The contracting agency
2. The contractor
3. The stakeholders.

Contractors are typically non-governmental organisations (NGO), commercial companies, national mine action bodies and/or military units. The most popular methods of engaging such actors are through grants (usually non-competitive) and contracts following competitive tendering processes.

Contracting agencies include national mine action authorities (NMMAA) or national mine action centres (NMAC), UN agencies, donors and civil engineering companies. Stakeholders include all those individuals and organisations that have an interest in the performance of the contract, and the work defined within it.

In one common contracting model the contracting agency awards a contract for specific clearance assets and then tasks the contractor with exact areas for clearance. The contractor has no scope or incentive to change the areas presented for clearance and is only compensated for the capacity provided and the exact area cleared. This method of contracting may be effective when the characteristics of mined areas are understood, confirmed (CHA) and have already been clearly defined.

However, in many instances areas are not confirmed to contain mines and/or ERW and they may be only loosely described and roughly delineated as suspected hazardous areas (SHA). In these cases internal management of the land release process and the contracting out of survey projects, often represents better value for money.

The land release process aims to release land from within SHAs and CHAs using the most efficient means. It is clear, however, that may be a real or perceived conflict of interest if a contractor makes most money from clearance work, but is expected to minimise the proportion of that type of work within a task area. In such situations, cost efficiency and confidence may be best achieved through contracting mechanisms that keep some of the land release decision-making functions within the contracting agency.
The mine action community continues to be challenged to appropriately address the concept of land release through non-technical means in mine action contracts. When contracts do seek to delegate more complex land release decision-making responsibilities to the contractor, basic principles and authorities should be included in the contract text.

The principles associated with defining roles and responsibilities of different parties, and ensuring that there are no conflicts of interest should be extended to demining that is to be conducted under other formal agreements such as Memoranda of Understanding. IMAS 07.20 provides guidance on mine action contracting.

The manner in which mine action contracting is carried out has an important role in ensuring that land release activities are necessary, effective and efficient.

**Liability**

Formalisation of land release methodologies (that deliver cancelled or reduced land that has not been subject to clearance to a specified depth) and the frequent contracting of demining capacities have increased interest in, and underline the importance of, liability and insurance in mine action.

The possibility of one or more mines or other ERW remaining after the handover of a cleared area is real. An item of ERW may be missed during clearance, or land may have been incorrectly released by survey when it was in fact contaminated. Subsequently, an injury or death may occur. As liability is usually linked to non-compliance with an agreed policy or procedure, the contracting agency and national authority should try to answer the question of legal responsibility for the damage and injury this missed ERW would, or did, cause.

It is generally accepted that a State is responsible for the safety of its citizens, and it is the government that should address the issue of reducing mine and ERW hazards on its territory and minimising related accidents.

During demining activities, this responsibility is often transferred to the organisation carrying out the operation. On completion of the work the government, or other landowner, should re-assume its responsibility for the released areas. It helps if the State has a standard for victim compensation, and a policy for dealing with residual risk (defined in the IMAS as *the risk remaining following the application of all reasonable efforts to discredit, remove, or destroy all mine or ERW hazards from a specified area to a specified depth*).
Individual occurrences are usually viewed on a case by case basis to see if there is evidence that the operator has been negligent. Among the global mine action community there is divergence in opinion regarding the party, or parties that should accept responsibility when an operator completes survey and clearance, and the area is to be handed over to the end user.

Not even IMAS-compliant full clearance, to a depth beyond the most conservative of the risk assessments, can offer absolute guarantees that an area is entirely free of explosive hazards. The IMAS does not attempt to stipulate universally applicable conditions for liability. Instead, they offer guidance based on experience and the available evidence. How is the quality of work being assessed? How is the residual risk understood and defined in the national legislation and standards for work? Is there a formal handover of land?

Questions of liability need to be considered, understood, resolved and agreed upon by the government, contracting agencies, contractors and stakeholders in affected communities, ideally before work starts. All stages in the process of land release should be documented, including decisions that were taken and what they were based upon. Information should be safely stored for future reference.

**Insurance**

Demining is carried out in a labour intensive and potentially hazardous environment, in which insurance is fundamental to addressing risks to people and material. Insurance is defined as the equitable transfer of the risk of a loss from one entity to another in exchange for payment of a premium. It should provide a measure of protection against negative consequences of an accident or other undesired human or material loss.

Importantly, insurance should not be perceived as providing mere protection, but also resilience for a client; enabling quick resetting of an operation or a person to a state close to that prevailing immediately prior to the loss. The cover available for demining personnel normally includes accidental death, loss of limb, and other permanent disability-related conditions, with cover for medical emergency and evacuation assistance, expenses and repatriation costs.

Within a well-developed market, other insurance may also be available to address contractors’ and employers’ concerns over the availability of equipment, interruptions to projects, aspects relating to professional advice and the consequences of accidents or incidents following their work.10
ENDNOTES

1  Normally between 5-20 percent

2  BOMICEN/VVAF (2005), Executive Summary, Unexploded Ordnance and Landmine Impact Assessment and Technical Survey Report, Phase 1 Hanoi, 14 October 2005, pp. 2–3

3  GICHD (to be released in 2014) A study of policy and practice in relation to residual World War II Unexploded Ordnance in Germany and the UK.


6  IMAS 04.10 states: ‘...The act of replacing safety devices such as pins or rods into an explosive item to prevent the fuze or igniter from functioning…’

7  IMAS 04.10 states: ‘...The act of making a mine or explosive ordnance safe by removing the fuze or igniter. The procedure normally removes one or more links from the firing chain…’

8  eg NATO STANAG, NORSOK, IMCA

9  eg IMAS incl. TNMA, ISACS, OSCE BP, CWA EOD Competency Standards