Andy Smith, 2016

Why is Humanitarian Mine Action a world apart from military demining?

Anyone working in Humanitarian Mine Action (HMA) really should understand what it is. Humanitarian demining is a small part of a much broader Humanitarian Mine Action effort to promote international human rights values in a post-conflict country.

This paper sets out to explain:

- The difference between “Humanitarian Mine Action” and “humanitarian demining”; and
- Why humanitarian demining is not done in the same way as military demining.

It is also intended to introduce the idea that genuinely humanitarian demining cannot be conducted in isolation from the broader goals of Humanitarian Mine Action as a whole.

First, why is humanitarian demining done?

Of course, we conduct humanitarian demining to prevent unnecessary civilian injury and death and to let children grow up in safety, but there is more to it than that.

When it began, humanitarian demining was only funded by the people in Western countries giving money to demining charities. With the success of the Antipersonnel Mine Ban Treaty, signatory governments were obliged to help countries that could not afford to clear their own mines, so a lot of funding started to come from government aid provisions. Today, the money paying for humanitarian demining comes largely from wealthy Western nations: the biggest donors are the USA, Japan and the European Union. This variation in the main funding source explains why the humanitarian imperative that started Humanitarian Mine Action and the Antipersonnel Mine Ban Treaty has sometimes been distorted as donors began basing support on a politically motivated international security agenda rather than humanitarian concerns. This change has led to an increased involvement of the military in humanitarian demining in some countries and reinforced their dominance in organisations like UNMAS and the Geneva Centre for Humanitarian Demining (GICHD).

That's not entirely new. In some countries, the military, civil defence or specialist police units got involved in humanitarian demining long ago. For example, in Croatia special military demining teams were the first to start demining work. And in Angola, many of the defeated military forces were given a role in the State's demining programme when the long war ended. In that case, giving the former enemy useful employment and status helped to avoid them turning to banditry or returning to conflict.

The pursuit of Humanitarian Mine Action principles is part of internationally supported efforts to break cycles of conflict because those principles are a necessary part of supporting the conditions to build peace, security, stability and a stable economy. As part of that, humanitarian demining encourages countries to join the international community by clearing their mines to an internationally recognised standard as defined in the International Mine Action Standards (IMAS).

Why only mines?

The words "mine" and "demining" are misleading in Humanitarian Mine Action or humanitarian demining because it has never been only mines that are cleared by deminers.

Every kind of munition that may be unexploded or abandoned must be removed. In minefields I have seen, these have ranged from rifle grenades and mortar bombs to booby traps, submunitions, rockets, artillery munitions, guns and small arms ammunition, and large air-dropped bombs. Collectively, these are often called the Explosive Remnants of War (ERW), or simply "explosive hazards".

The picture on the left shows the explosive hazards recovered from a typical minefield in Southern Angola in one day.

Humanitarian Mine Action

Humanitarian Mine Action is about more than removing the threats from explosive hazards by doing demining. It covers five areas that are known in the industry as "pillars".

Five pillars (foundations) of Humanitarian Mine Action

- Mine Risk Education
- Survey and demining
- Stockpile reduction
- Victim assistance
- Advocacy

It is easy to see how stockpile reduction, victim assistance and advocacy all involve significant political buy-in to liberal humanitarian values, or Western security interests. The way that survey and demining is conducted can reinforce that, or not as the case may be.

International Mine Action Standards

These pillars of Humanitarian Mine Action are derived from the Ottawa Convention, the Antipersonnel Mine Ban Treaty.

The International Mine Action Standards (IMAS) were developed in support of the five pillars and are intended to provide guidance in all of them.

Around the world, no one likes the thought of the UN imposing standards on what happens in their country so I find it helpful to stress that the International Mine Action Standards were not written by the UN. When the UN tried to write standards they produced a set of unworkable ideals[1] that no organisation could comply with. The current International standards (first released in 2001) were originally written by elected representatives from demining organisations and countries where demining was being conducted. To get consensus, the IMAS are largely guidelines that say what should be achieved. They are not detailed Operating Procedures that tell anyone how they must work. They are intended to help each country set its own standards which can be given more detail to fit their particular context.

In theory, each country then prepares its own country specific National Mine Action Standards (NMAS), but many do not take that seriously. Many NMAS are direct translations of the IMAS. Many have no foundation in national law so their requirements cannot actually be enforced.

Underneath international or national standards, each organisation working in Humanitarian Mine Action (whatever "pillar") should have its own Standing Operating Procedures (SOPs). In demining, the Operating Procedures describe in detail the procedures that the deminers use to safely clear land for civilian use. They all have to achieve that goal but there is no agreement about how to do that so each group's Operating Procedures are different. Actually a fair number are based on the Generic SOPs you will find on my website[2]. (They were written after seeing how people worked, so are not "my" SOPs, rather a compilation of the best procedures I could find.)

Differences between humanitarian and military demining

Demining in combat is very different to demining in times of peace. This is because the two activities are done for different reasons and have different goals.

1. First, the beneficiaries are not the same. Those who benefit from combat demining are the military. In humanitarian demining, those who benefit must always be civilian.
2. Second: the end-result is not the same. Demining in combat is about reducing risk, not eliminating risk, because it can make sense to accept a few casualties in a combat situation. In humanitarian demining, risk to the deminer and to the people who use the land should always be as close to ZERO as possible so no explosive hazards can be left behind.
3. Third: the need for demining to be done quickly and covertly without the approval of the enemy is absent in humanitarian demining. The only pressure for speed should be the need to finish and move on to remove the hazard from other civilian areas.
4. Fourth: the cost of combat demining is always borne by those paying the soldiers. The cost of humanitarian demining is usually supported by the international community as aid, and to fulfil their obligation under the Mine Ban treaty to help pay to clear explosive hazards in countries that cannot afford to do it.

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[1] The UN Mine Action Standards produced after a 1997 conference in Copenhagen so often referred to as the "Copenhagen Standards".

[2] http://www.nolandmines.com/Generic%20SOPs.htm

5. Fifth: military demining is conducted for a strategic advantage. Humanitarian demining is conducted as part of Humanitarian Mine Action with the aim of promoting the long-term and sustainable adoption of a humanitarian mindset across society as part of building peace and respect for human rights.

Military procedures used for combat demining cannot be used in humanitarian demining because they cannot achieve what is defined as "clearance" in the IMAS.

Clearance is defined in IMAS 07.10 as:

> ***"the identification and removal or destruction of all mine and ERW hazards from a specified area to a specified depth"***

Why is Mine Risk Education part of humanitarian demining?

People often think that mines present the greatest threat to civilians but this is rarely true. In most areas, it is other munitions that injure most civilians. Mines can be a major cause of injury when displaced people are returning to their home areas, but after that – it is the other munitions left over after conflict that are the greatest cause of injury.

These PFM-1s[3] were used a lot on the border between Afghanistan and Tajikistan. They are an air dispersed anti-personnel mine – so are both an AP mine and a submunition.

Scattered from helicopters and spinning like sycamore seeds, they are mostly found lying on the surface.

In most cases, the sun hardens the soft plastic case and it splits allowing the liquid explosive to evaporate. The VS6-D liquid explosive in these is particularly hazardous to inhale, but after it has evaporated, only the detonator remains.

Children throw rocks at them to try to make the detonator explode – without realising how easily they could be blinded.

Most civilian accidents occur as a result of deliberate interaction with unexploded or abandoned munitions. People do this out of curiosity, bravado or a desire to earn a few pennies by recycling the materials in them. Often, they do it out of ignorance because they do not know the risks they are taking. Mine Risk Education can save their lives.

In many cases demining groups conduct Mine Risk Education sessions where they are working. This gets them into cooperative contact with the local community who can often give them useful information about the problem in their area. Effective liaison with the community can

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[3] Please do not think that these are a special evil designed by the Russians with the intent of attracting interest from children. They are shaped that way to aid air dispersal and are a copy of a similar mine developed by the USA and used widely in Vietnam – creatively named the "Dragon's tooth".

make their demining work much more efficient and effective because no one knows as much about the problem on the ground as the people living there.

Why not use military breaching methods?

Military breaching uses mechanical, manual or explosive means. The explosive methods (such as the Viper which uses a long hose filled with explosives to blast a route across a minefield) can be ruled about because they would be impossibly expensive and potentially polluting if used over wide areas. They also do not work well enough to clear ground to humanitarian standards.

The machines often used by the military for breaching minefields are also not effective enough. Flails, tillers, bulldozers and rollers can be useful tools when trying to make a fast breach over a minefield during combat. However, in humanitarian demining, they can never clear ground to the standard required.

Bulldozers just move the problem from one place to another.

This is an armoured bulldozer being used in Iraq. All it did was push the mines and munitions into a pile that was then very hazardous to search through.

Flails can break mines and throw them around, or push them deeper into the ground…

The flail chain and hammers can damage munitions but very rarely detonate them. They can detonate some pressure activated mines, but they cannot pull the pins on tripwire initiated mines. They are also usually horribly expensive in fuel and spares to use for extended periods of time.

This flail in Sudan was so inefficient that it ran over an anti-tank mine that the flail did not detonate. The cab burst open and the driver was injured.

Tillers are no more efficient.

This tiller in Jordan destroyed the mine-lines by moving mines and pushing them deep into the sand, making manual clearance behind the machine much more difficult than necessary.

Ploughs and rollers are also unable to remove all explosive hazards to the standard required.

This picture shows on the far right an old Soviet T55 bridge-layer tank with KMT5 roller system and on the left, the US developed “mine clearance cultivator”, a kind of mine plough.

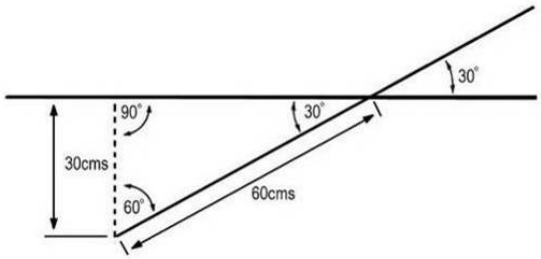
They both destroyed themselves[4] when detonating AT mines and both had left all the anti-personnel mines and other munitions behind.

One might use any of these machines to make a path through a minefield during conflict because they can all reduce the risk of soldiers stepping on mines. But they do not work well enough to leave land that would be safe for children to play on.

Using prodders to detect mines

Prodding to locate mines is not appropriate for use in humanitarian demining because it is too unsafe – for the deminer and for the person who will use the land. When a soldier is trapped in a minefield under fire, the only thing he can do may be to prod his way out. But using a prodder as a mean of detecting mines is less effective and more hazardous than all the other methods commonly used.

Finding mines with a prodder involves pushing a tool into the ground and relying on feeling an obstruction that may be a mine. You have to prod at a low angle to the ground to make it more likely that you hit the side of the mine than the top.



To prod to a depth of 30cms, the blade of the prodder would have to be 60cms in the ground. Apart from the fact that most prodders do not have a blade half as long as that, it has been proven that it is impossible to prod to depths greater than 10cms even in loose sand without applying so much pressure that an anti-personnel mine would be initiated.

In 2004, I conducted a series of trials for the Geneva International Centre for Humanitarian Demining that were designed to compare the relative safety and speed of different manual demining systems.[5] The trials identified prodding as the most dangerous method tested due to its potential threat to deminer safety and the risk of leaving mines behind.

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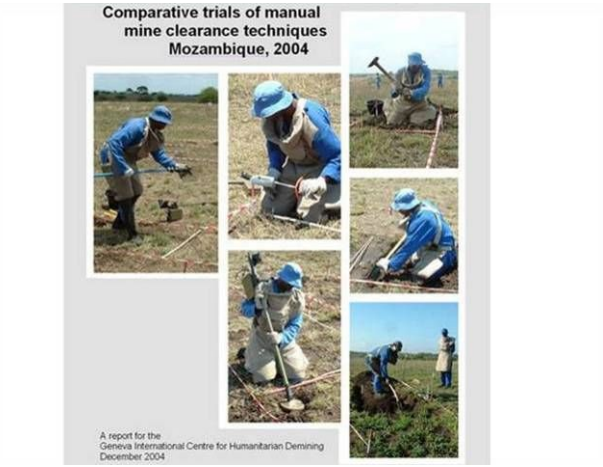
[4] See DDAS accident 385 in the Database of Demining Accidents, www.ddasonline.com

[5] *Conducted in Mozambique, the trial was designed by me and implemented in collaboration with GICHD, the U.K.’s defence-technology company QinetiQ, and the German Federal Institute for Materials Research and Testing known as BAM.*



In the prodder trial, all mines below 10 cm were missed. All shallow mines that were found had been subjected to excess pressure and would have detonated if they had been real. So, despite prodding every inch of the ground, the deminer could not search the soil deeply enough to reliably locate the mines.

The trial results found that trying to locate mines by prodding is more likely to detonate the mine than any other manual demining method[6] and was also more likely to leave mines behind than any other manual demining method.

Professor Trevelyan of the University of Western Australia conducted some prodding experiments in loose sand and found that it was not possible to prod to a 10cm depth at 30 degrees to the ground without the use of excessive pressure[7] .

Military deminers often use prodders like these.

I was given the really long green one in Afghanistan, the other comes from Bosnia. I like them because they are very long so put distance between the deminers' hands/eyes and the mine. But it is still impossible to prod to a depth of 10cm at a 30 degree angle with them – so mines and ERW will be left behind if they are used to detect them. In really hard or rocky ground, it can be impossible to prod at all. And of course, prodding every centimetre with one of these is also very slow – so using a prodder to detect mines makes no sense at all in humanitarian demining.

[6] *http://www.jmu.edu/cisr/journal/18.1/notes/smith.shtml*

[7] *Statistical Analysis and Experiments in Manual Demining, 2003*

This man's head is in the worst possible place if a detonation occurs. The blast will spray soil and rocks in his face at high speed and the expanding shock wave will wrench his head backwards. It is extremely rare for anyone to work lying down during humanitarian demining - but it can be essential for a soldier who is under fire to keep low to the ground.

Safe and efficient

The table below shows how efficient various demining methods are.

Type of asset	Assessment of quality of demining assets	Probability of detection
Manual mine clearance	All mines and ERW are found to the required depth.	100%
MDD, two dogs	IMAS considers search by two dogs as sufficient – as long as the dogs are appropriately trained. Actual clearance of dog indications is conducted manually.	100%
MDD, one dog	Search by a single dog lacks the quality control of a second dog, so is not sufficient.	0-90%
Flail and tiller	Performance is very varied. Not more than 80% of mines and as low as 0% of other ERW.	40-80%
Rollers	Performance depends on the ground and type of mines.	0-40%

This table is derived from a study published by the Norwegians in the JMU Journal of ERW and Mine Action in 2014 – but it has my experience overlaid because its author was wrong[8].

Amongst deminers around the world, it is generally agreed that manual demining is the only way of being 100% sure that the land is safe for children to use, livestock to roam, people to farm or just walk across on their way to work.

While doing this, we have to keep the deminers safe. I kept the Database of Demining Accidents for 15 years. The activity at the time of the accidents is recorded – and the most dangerous activity by far is when digging to uncover a mine. Sometimes prodders are used to help uncover a mine, but that is not the same as using a prodder to detect where the buried hazard is.

[8] *I have explained why in detail very publicly and received no counter-arguments, leading me to conclude that the unscientific approach cannot be readily defended.*

How humanitarian manual demining differs from this

The major practical differences between humanitarian and military demining can be summarised as:

- Marking requirements;
- Detection methods;
- Excavation procedures and tools;
- Use of machines;
- PPE design and use; and
- Quality Management requirements.

Marking in Humanitarian Mine Action

Marking is rather more complex than it sounds.

Unlike soldiers, because no one is shooting at us, we can afford to spend time marking the ground in a way that means we are 100% sure we have searched it all – and that no deminers or civilians walk on land until after it has been searched.

First we have area marking that is placed as warnings outside the area that is believed to be hazardous. Signage is placed around the perimeter of the area so that people are warned not to enter. Painted concrete and steel boards are used as well as the more common plastic signs. In most countries, these perimeter signs include a skull and crossbones. The Tajikistan sign on the right is unusual because it does not include a skull and crossbones but it gets the message across very well with a graphic.

Perimeter marking may have to survive a long time before demining is conducted. Some is made using reinforcing bar. Others like the ones shown on the right are cast in concrete and painted before being placed.

Ideally perimeter marking would include a fence, but generally this is too expensive and would often be stolen. Signs which are spaced so that when you are standing beside one, you can always see the next sign are

usually considered enough. Each country must decide what marking will be enough to guarantee that the people do not accidentally enter the hazardous area.

The GPS position of every marker on the perimeter provides the basis for the task map.

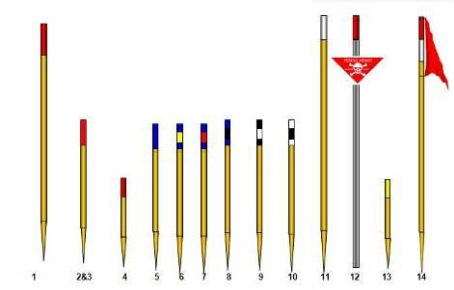
Marking during actual demining

Then there is the marking used during demining which is used to guarantee the safety of the deminer, any site visitors, and the people who will use the land. It is only by marking properly as work is conducted that we can be sure that every bit of the land is thoroughly searched.

A benchmark is marked with some kind of permanent marker. The benchmark is the point from which all measurements are made and maps are drawn.

From the benchmark, the deminers mark a start-point and a start-line. This is always in an area known to be safe. It marks the start of the work and any deminers on the other side of the start-line should only be in cleared areas until you are confident that there is nothing there. Very often some of the area on the other side of the start line is reduced after the mines are located. If there are mines or munitions scattered all over the area we may have to clear it all, but that doesn't happen very often.

This picture on the right shows a Start Point (the stone with SP painted on it) and a start line marked in red stones in Afghanistan. The line of white stones indicate which side of the red stones is safe. When I was last in Afghanistan, flags and cloth tape were also used in some areas.

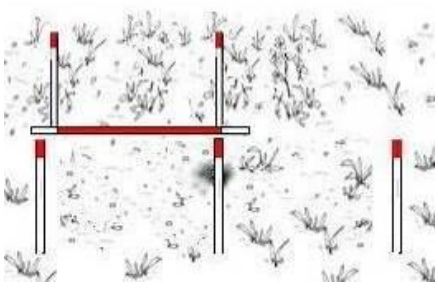


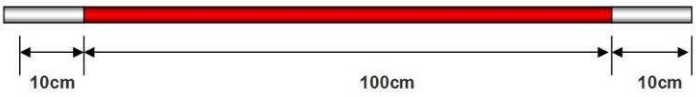
1. Hazardous Area picket	Red topped	1.2m
2. Corner picket	Red topped	0.6m
3. Lane closure pickets	Red topped	0.6m x 2 crossed
4. Lane marking picket	Red topped	0.3m
5. Discovered AP mine picket	Blue topped	0.6m
6. Discovered AG mine picket	Blue with red stripe	0.6m
7. Discovered AT mine picket	Blue with yellow stripe	0.6m
8. Discovered ordnance picket	Blue with black stripe	0.6m
9. Section Leader QA picket	Black with white stripe	0.6m
10. Platoon Commander QA picket	White with black stripe	0.6m
11. Reference pickets	White topped	1.2m
12. Semi-Permanent Marking picket	Red topped	1.2m steel (may be concreted)
13. Start finish pickets	Yellow topped	0.6m
14. Section picket (road Clearance)	White/red tipped, with flag	1.2m

Different groups use different methods of marking while they work. On the left is the standard system used by the government demining forces in Angola. The sticks are used to mark the division between searched and unsearched areas, but also the position of any mines and ERW found.

They are also used to mark the extent of the Quality Assurance checks that have been conducted on each deminer's work.

Deminers work from the start line. Generally they search metre wide paths into the hazardous area, marking each metre as they advance. At the end of the lane the deminer uses a base-stick that he/she must not step beyond. Generally the deminers cut undergrowth and use a metal detector for about half a metre in front of the base-stick and when they are happy that there is nothing there, they move the base-stick forward and start again.





Different demining groups use different base-sticks, but they are all about a metre wide with 10cm extra at each end. In the lower picture, there is a fabric tape attached to the base-stick. The tape is unwound as the deminer progresses, marking the side of the lane clearly. Because it is raised off the ground, the detector can be used underneath this base stick.

This picture on the right shows a deminer working with a mixture of stones, sticks and rope marking in Sudan.

Starting over or under the base-stick, the deminer searches across the 120 cm width of the base-stick with a metal detector, but only records the metre in the centre as searched when placing side of lane marking. This guarantees that when search is conducted in the adjacent lane there will always be an overlap. In the early days of humanitarian demining, deminers only searched the metre in the centre, then the deminer in the lane alongside did the same. Mines were missed in the line between one lane and another and deminers lost their feet as a result, so an overlap was introduced. Searching a small area twice takes very little time because any metal present was removed when it was first searched.

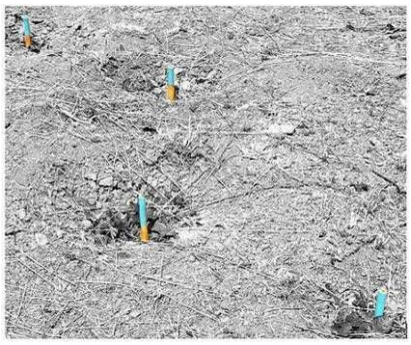
When the deminer stops work in the lane, at a rest break or at the end of the working day, he/she marks the place where the base-stick was last placed so that no one walks too far by mistake.

On the left, the crossed sticks mark the end of the cleared lanes. A line of red stones may be used in another country, or rope, or plastic tape.

In this minefield in Bosnia, the deminers link each wooden marking stick with plastic tape. In windy areas or areas where livestock moves through the area at night, plastic tape is often damaged.

In Croatia, marking is often done using a heavy plastic tape tied to undergrowth at the edge of the cleared area, or lighter tape tied to tufts of grass.

When a mine or other explosive device is found, the deminers may mark it for a supervisor to recover and destroy, or may recover it themselves. This varies from group to group because some do not train their deminers to handle explosive devices.



After the device has been removed, a marker is placed where it was found. This allows the supervisors to begin to see any pattern that there may be. There is always a pattern of some kind in minefields that were placed to make a defensive barrier.

When mines are missing from a pattern and there is no evidence of them having detonated, it is often necessary to search deeper in those places or to extend the search area to include places where they may have moved.

So there needs to be a marking system that means that everyone always knows where it is safe to walk and it is easy to see where mines and hazards have been found.

Marking After Demining

When the work has been finished, we place a permanent marker on the ground and record its GPS position so that we can find the area again later (this may be the same marker as the Benchmark).

These are usually made out of concrete with scrap metal inside and with identification details on the top.

Of relevance to the use of machines is the need for site marking requirements to be maintained well enough to ensure safety. Marking is often moved temporarily and replaced immediately after a machine has passed. If a machine disrupts a mine pattern, it will not be possible to mark where each mine had been. If a machine disturbs permanent marking, that affects the accurate recording of the area so can be a critical problem.

Detection methods in HMA

Ground Penetrating Radar, infrared, acoustic tomography, microwave and many other technologies are being worked on, but are not yet reliable so the detection methods used still involve using dogs or metal-detectors.

The effectiveness of dogs is controversial. They can work well, but the cost of training them and keeping them working well is very high. It has been found that two dogs have to be used in each search to guarantee performance.

Manual demining is conducted using metal-detectors or area-excavation techniques. Very rarely the metal detector may be a dual-sensor detector but the use of these is rare because they add no value and have been shown to increase risk. This deminer is working in Angola using an old Schiebel AN-19 detector that has very limited performance.

Over recent years, detectors have got shorter to allow deminers to work squatting or on their knees, and they have got smarter.

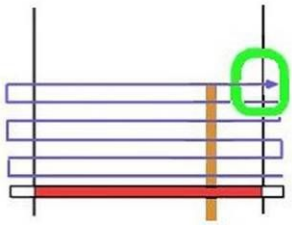
Some detectors fold up really small for transport and can be extended to variable lengths so that the deminer can work standing or on his/her knees.

On the left is a deminer in Cambodia. Notice that he is using a different marking system. The lane marking is done using coloured rope and he has two base-sticks. When he has searched between the base-sticks, he moves the back one to the front and searches again.

To be sure that the detector can locate the mines we are looking for in the ground at the minefield, it is wise to bury a target mine at the required clearance depth and practice using it. The target mine is a real mine that has been rendered safe. It is usual to mark target mines so that they do not get confused with live mines.

As the deminer moves the search-head of the detector forward, he/she advances by half a detector head-width at a time and makes sure to cover the entire ground surface.

You have to overlap the search-head as you advance because the depth beneath the search head that is searched is usually not constant across its width.



With most detectors, the searched area is a semi-circle under the search-head shaped as shown above left, so the maximum search depth is only achieved in the centre of the search-head. The shape actually changes depending on the metal content of the target, but it remains a cone or dome. This is the shape that this detector had when searching for the small metal content inside Chinese Type 72 anti-personnel mines.

Metal detectors have improved immensely during my time in demining. These days they can reliably ignore mineral content in the ground and some can ‘kind-of’ discriminate between types of metal, but the main problem with metal detectors is when using them in areas where there is a lot of scrap metal lying around. This can happen in or near towns and very often happens in battle areas. They may signal all the time – but not with false alarms because there is always metal there and they are only metal-detectors, not mine-detectors.

On the left are some fragments from minefields that I once sorted out for a detector trial. All except the ring-pull from a can are magnetic. On the right, the larger battlefield debris is from a site in Iraq.

BAC detectors

When an area is not mined but there may be abandoned or unexploded munitions on the ground, humanitarian demining organisations conduct what we call Battle Area Clearance (BAC).

Because there are no mines, people can walk the land safely. At its simplest, BAC is a disciplined visual search of the ground surface. All visible battle scrap is removed so the people will not mistake it for something dangerous. If the searchers find something hazardous, its condition will be assessed before deciding whether to move it for destruction or mark it and destroy it where it is.

When we suspect that there may be non-mine munitions beneath the ground surface, we conduct Battle Area Clearance Subsurface. This is often conducted in areas where buildings may be constructed or where agricultural activities will involve ploughing the ground. Those two uses of the land will require searching to different depths.

Different “Large-loop” detectors are generally used for this.

Some have very large search heads that need to be carried by more than one person. Some record what they find with sophisticated computers and make a map showing where the targets are so that you can return later to excavate them.

Others look far more familiar and are used in a similar way to the mine detectors used to search for mines. Some can search deeply for large metal objects. Others search less deeply but can find smaller items. Many of them cannot search across a range of depths reliably. So, for example, a large-loop detector that can find a submunition at 50cm deep may miss the same submunition when it is only 15cm beneath the ground surface.

At this time, there is no reliable way to be sure which detector to buy without testing it against the targets you want to find – and across the range of depths that you think they may be under the ground. The Geneva International Centre for Humanitarian Demining conducted some comparative performance tests on these deep-search BAC detectors in 2014 but the report has not yet been published.

And of course detectors can be mounted onto vehicles, which can speed up the search. But I have never seen an effective system of actually marking where the signal is beneath a large detector search-head (array), so these vehicle mounted systems are of limited value. They are usually towed behind a mine protected vehicle and have a poor reputation because they cannot work reliably at any speed. They might find a large metal-cased Anti-Tank mine on a road but would not find a plastic cased mine the same size. (All plastic cased mines found in every country I have worked have still had a small metal content.)

Excavation during Humanitarian Demining

While prodding is not used as a method of finding mines, prodders are used with other hand-tools to help uncover things that have been found using other methods.

After the deminer has pinpointed a metal signal under the ground and placed a signal marker, the detector is put aside and the excavation begins.

Most battle debris has a ferrous content so is magnetic, so many deminers use a magnet over the ground surface to try to locate fragments of metal that may have made the detector signal. Small and powerful neodymium magnets are very effective. If the deminers finds metal, they search with the detector again and if the signal has gone, they can get on with using the metal-detector. This deminer is using a scraping tool that I designed.

It is a long stainless steel trowel with a neodymium magnet clip on one side. The trowel is made using low-grade stainless steel that has been found to be very resilient in a blast, bending rather than breaking into fragments. When the tool you are using breaks up, it can turn a blast mine into a fragmentation mine and parts of the tool can cause severe injury.

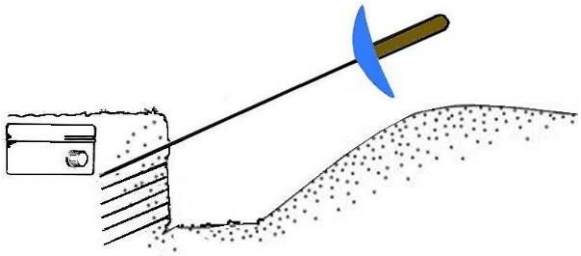
The deminer should approach the signal from the side so that he does not press on the top and detonate the mine.

Detonating a mine while trying to uncover it is the most common demining accident.

When the ground is very hard, it can be necessary to use heavy tools to start the excavation and dig down to the clearance depth before changing tools to move forward more cautiously towards the metal detector signal. I like this two-handed straight pick.

In Croatia the deminers use another two-handed tool that I also found easy to use accurately. It looks dangerous, but by the way it is used, it is a safe tool. The lump on the end of the handle is a neodymium magnet.

These tools are reminiscent of the pick-axes used in Afghanistan. When used correctly, they are also safe ways to start an excavation.



Using picks, scrapers and then sometimes prodders, the aim is to find the side of the mine and expose it gently so that it can be identified without applying any pressure on the top.

Area excavation

When there are a lot of metal fragments in an area, or where detectors and batteries are not available, area excavation methods can be used.

In area excavation, the whole ground surface is dug away to an agreed depth. Generally, the ground is put back behind the deminer as he works.

A variety of methods are used. From the left this picture shows demining rakes being used in Jordan and Sri Lanka, the mattock method that one INGO uses in every country where it works, a short hand-tool favoured by another INGO, and the garden spade method favoured by the national clearance group in Mozambique. Surprisingly, the garden spade method is remarkably safe - but unsurprisingly, there have been many accidents with the mattock. The rake method is probably the fastest and the safest except on very hard ground.

In hard ground all the methods are slow but in softer ground with a lot of metal fragments, these methods can be faster than using a metal-detector. Even when they are not faster, they are very thorough, allow markers to be placed where each mine is found, are cheap and guarantee that nothing is left behind to injure those using the land – which is the bottom line.

One advantage of using area excavation methods is that you do not have to buy expensive imported detectors and a constant supply of batteries. A good detector may cost between 2.5 and 3.5 thousand US dollars and every man working in the minefield will need one. A pair of demining rakes will cost just a few dollars and can be locally made. This means that the money spent on demining in a country stays in the country and supports the recovery of its post-conflict economy by providing employment and salaries.

Humanitarian demining machines

Big machines originally designed for military breeching are used in Humanitarian Mine Action and can be useful to remove undergrowth, try to locate where the mines are or raise confidence. Smaller machines have also been developed for anti-personnel mine areas.

Before detecting or excavating in an area, the undergrowth needs to be removed. This is often done manually using hand tools such as shears and sickles, but some use petrol strimmers.

Larger machines are used to both remove the undergrowth and prepare the ground surface.

Mechanical methods of removing undergrowth usually involve processing the ground in some way, using flails, rakes, ploughs or tillers. Sometimes these are intended to detonate mines as they work, but they do not detonate all the explosive hazards present so manual demining is still needed afterwards to meet the standard for clearance in humanitarian demining.

The major problem with using machines that drive over the hazardous area is their vulnerability to Anti-Tank mines. Of course, these mines were designed to disable a battle tank so it is hard to design any machine that is stronger.

Trying to detonate mines with machines

On the right is a large Aardvark flail awaiting spare parts in Angola.

Most big machines like this are designed to withstand an Anti-Tank mine under their working tool. The tool may be damaged and is supposed to be easily repairable in the field. But it is not only the tool that is damaged.

Experience has shown that these machines cannot withstand many big blasts without the shockwaves damaging parts of the main machine. Welds crack, circuit boards fracture and bearings are damaged, which can mean very expensive repairs in sophisticated workshops.

Generally, even if a machine can withstand a mine blast it only makes sense to use a machine to find the first mine in a pattern with a single detonation, then withdraw the machine and use manual demining techniques to clear the mine pattern or “mine-lines”.

I have found that using machines to try to detonate pressure mines over an area can be counter-productive because:

- Ground conditions are so varied that the ground may have been artificially levelled by the machine. This can bury mines that are in a low spot, making them too deep to detect with another method;
- Some mines will be damaged, not detonated, and all ordnance will be left behind so the area will have to be searched manually afterwards;

- Any mine-laying pattern is destroyed so the manual deminers usually have to search a considerably wider area after machine use; and
- Repairs and running costs are so high that much of the money given to help stabilise a post-conflict country is not spent there.

Not pretending the machine can clear anything

So in humanitarian demining, machines are useful for area preparation, finding mine-lines in Technical Survey and in confidence building.

The MV4 mini-flail, APT vegetation cutter and Arjun back-hoe are examples of tools that can help to locate where the mines are. The MV4 does this by detonating one or more mines in a mine-line with a flail or tiller.

The APT machine may do this by safely detonating surface anti-personnel mines under its wheels or mulching tool while it cuts undergrowth, but it is not designed to find mines, rather to simply cut undergrowth and prepare the ground to a maximum of a few centimetres.

The Arjun is a converted back-hoe. It finds the mined area by exposing one or more mines in a mine-line.

The simple and clever part of the Arjun is a two part replacement tool that first cuts the undergrowth and then rakes the ground surface, tearing out root systems that prevent deminers being able to excavate safely. With no moving parts, it is very strong and simple to maintain.

This is one of 14 Arjun machines used in Sri Lanka by several demining groups in 2011. It was developed by an Indian demining NGO. Although it is a great machine, I don't think anyone is using it today because no one is making them commercially. The Sri Lanka machines were converted back to standard back-hoes and sold off when the funding dried up. The same machines are now helping with post-conflict reconstruction.

Because none of the smaller machines can survive an Anti-Tank mine blast, it can be necessary to manually clear some of an area to be sure no large mines are present before using a small machine. In fact, Arjun's rake proved to be an exception in Sri Lanka, where is

successfully exposed many Anti-Tank mines without any detonations. If an Arjun had been driven onto an Anti-Tank mine it would have been severely damaged or destroyed, which shows that it is not just the machine, but the way it is used that make its use safe.

This is an early MV4 after detonating an anti-tank mine as it turned. The machine was not repairable. The manufacturers claim that the current design can survive AT mines under the flail with repairable damage but I don't find that entirely credible. Most demining machine manufacturers have a poor reputation after having oversold their machines for years.

If there is a risk that there may be anti-tank mines present, it is necessary to use a larger machine for any ground processing and the best I know is the Minewolf.

Minewolf operators have told me that it should never be used to try to detonate a line of anti-tank mines because after between ten and twenty detonations under the flail or tiller, it will need major repair because of accumulated shock-wave damage.

Ground-engaging machines can also be used as a confidence building measure.

Because they will usually detonate or expose some of the mines, running a machine over an area can give confidence that there are no mine concentrations there. For example, people may have avoided a wide area because of the mines there, but the mines were actually only in a small part of that area. After clearing the mines, driving the machine over the rest of the area can give the end-users of the land confidence that the whole problem has been dealt with. After a machine is used in this way, visual Battle Area Clearance should be conducted over the ground that the machine has processed, so locating anything that may have been exposed (mines, parts of mines, or other ERW) and demonstrating that the deminers are not afraid to use the land. Of course, if any evidence of explosive hazards is found during the BAC, the relevant areas will have to be properly searched manually.

Machines cannot clear ground

First, let's be pedantic and insist that ground is not "cleared": ground is searched and mines and explosive devices are then cleared. A machine that is designed to detonate or disrupt pressure activated mines cannot do the same with every kind of munition. They are not even designed to do this because it is not desirable that they should detonate armour piercing munitions or large bombs that might completely destroy them.

It is uncontroversial for me to claim that at least 10% of all munitions used in conflict do not function as designed – so it is very common to find minefields strewn with unexploded rifle grenades, RPGs, mortar bombs, cluster bombs, etc. For the land to be declared explosive hazard-free to an agreed depth, all of those must be removed – not simply the pressure mines that rollers, tillers or flails *may* break or detonate.

Ground processing machines can reduce risk for the deminers by:

- removing undergrowth or obstructions;
- preparing the ground surface to make exposing hazards safer; and
- initiating or breaking proximity, pressure, or tripwire fuzed devices.

Machines can also increase the speed of demining by:

- allowing visual inspection;
- locating mine-lines;
- exposing devices or parts of devices;
- processing large areas in advance of BAC; and
- giving end-users confidence that the area is safe to use.

All these can be very valuable but they are in support of manual search methods, they do not replace any of them.

Personal Protective Equipment (PPE) used in HMA

PPE designed for demining would not be much use for a combat soldier. It is designed to be as comfortable as possible so that it can be used for long periods in hot weather. It also has to be as light as possible, allow the deminer to stand and kneel easily, and provide protection against the most common accident – which is an anti-personnel blast mine detonating 60cm in front of the deminer's face while he/she is exposing it.

The International Mine Action Standards require that a deminer have, as a minimum, frontal body protection and eye protection. They recommend that demining organisations consider the use of blast resistant tools.

The accident record shows the most common injuries to be in this order: Eyes; Hands; Arms; Legs; Body; Feet. Injuries to feet used to be much more common but the use of better metal-detectors and marking systems have largely stopped deminers stepping on mines.

So PPE for the eyes and the hands are most important. Protecting the eyes with a polycarbonate visor or goggles is fairly easy but protecting hands is more difficult because the deminer must remain able to feel what he is doing. Nonetheless, there is abundant evidence that blast resistant tools that are longer than usual can save fingers and hands, but many demining groups do not use them because they are not a requirement in the international standards.

Another part of PPE can be blast-resistant boots. Few groups use them because they don't work and can make injuries worse, but they really are not needed if the deminers are working properly.

Many deminers do worry about their hands and use tools that make them feel safer.

These excavation tools have all been presented to me by deminers. The bayonet at the top of the image on the right was given to me last year in Croatia. It is too short, but very easy to use. The tool in the middle was given to me by OMAR, a demining group in Afghanistan. The long Lee-Enfield bayonet at the bottom was presented to me in Mozambique and is my favourite. It is long enough to keep my hand a long way from any blast, and like all bayonets it can be used to scrape soil aside and twisted to break the ground up. When long bayonets like this have been involved in blasts they have bent and not broken into dangerous fragments.

Stainless steel rakes have been widely used both to excavate over wide areas and to investigate metal-detector readings. They provide protection by distance – and keeping further away from a blast is the best way to reduce the risk of injury if an accidental detonation occurs.

Within humanitarian demining, there is no general agreement about the best armour and eye protection to use. Demining groups generally choose what they are comfortable with. If the protection covers eyes and frontal body, it will be IMAS compliant.

These deminers in Nepal are wearing long frontal armour that extends below their knees. Their lightweight helmet only provides protection from the sun. Their 5mm thick polycarbonate visors are the minimum IMAS thickness.

They could have worn 5mm polycarbonate goggles like the deminer in Jordan shown on the right.

Or a face-mask like this deminer in Tajikistan.

Their demining body armour could be long enough to protect their legs when they kneel as with the deminer on the right. Notice the way that collar prevents any blast getting under the visor.

Or they can choose to use very small, and frankly “nominal”, PPE that has no collar to close off against the visor in a blast, as shown on the left.

The IMAS set a very low minimum requirement that many groups choose to exceed.

The armour in Kosovo shown on the right included a combat helmet and 13mm thick visor. It was so heavy that the deminers worked very slowly. Even in cold weather, deminers were sweating constantly and often unable to concentrate properly.

I do not wear a helmet because they are uncomfortable and heavy, and they are not much use in an accident. In a blast mine accident, they are not needed. In a fragmentation mine accident, they are not effective.

The picture on the right shows the helmet used by a deminer in Bosnia when he detonated a PROM-1 fragmentation mine with the search-head of his metal-detector. So I see no reason to wear one, but some humanitarian demining groups do choose to wear helmets as shown below, even in hot climates like Iraq.

Quality Management

Because it is not a combat activity, there is the time for internal and external Quality Management requirements in humanitarian demining. They are designed to ensure that approved systems are in place for:

1. planning;
2. quality assurance;
3. quality control; and
4. quality improvement.

Quality Management is intended to ensure that the work is done to the right standard and in the right way. The management system should continue to work even when staff change or are absent. The system should ensure that it does not matter who does the job, or when: it will always be a good job.

Internal Quality Assurance is conducted while the deminers are working to ensure that the approved procedures are always followed. Activities at every stage are documented so that any errors can be identified and corrected. Simple forms can make recording data fast and ensure that the correct data is recorded.

The collection of data allows managers to make informed decisions based on evidence when they decide to change the way that things are done. And they should change things because a Quality Management system includes making continual improvements that make the work safer and more efficient.

But the fact is that no two demining organisations I know use the same Quality Management system. Their paperwork varies, their command structures are different, and they make decisions in different ways, so there is no one system to use.

National authorities often use a computer based data storage system called IMSMA, which only stores data, it does not dictate how the information is used.

The way that a Quality Management system works will often depend on culture, education and what it is practical to achieve – so imposing an out of the box system never works.

When I have tried to build a Quality Management system as a demining group manager, I have tried to:

- Guarantee that all staff are appropriately trained/experienced to conduct the tasks required of them and that they have all the information necessary to do a good job;
- Ensure that all staff are appropriately equipped to conduct the tasks required of them safely and efficiently;
- Make a written Work Plan for each task and revise it as work progresses;
- Ensure that a written Risk Assessment that really does minimise risk to the workers and to those using the land is produced for each task;
- Ensure that all Risk Assessments are updated as new information is gathered during the task and that appropriate variations in procedures and processes are immediately adopted when necessary to ensure that risk is always minimised;
- Ensure that all Task Work Plans take due account of the need for environmental conservation whenever reasonable;
- Ensure that all worksites meet these minimum requirements:
    - maintain appropriate work and rest periods;
    - maintain obvious and unambiguous site marking;
    - control the movement of deminers, machines, visitors and the public;
    - provide effective supervision for all Task site activity;
    - enforce working-distances appropriate to the remaining risk; and
- Ensure that appropriate and adequate medical and traumatic injury provision (covering everything from immediate treatment to injury compensation insurance) is made for all staff.

Most of this is common-sense, but it helps if it is formalised so that parts are never forgotten.

External Quality Management systems are controlled by National Mine Action Centres or sometimes by donors. Often UN supported, they should include sending someone who is not part of the demining team to make Quality Assurance checks to confirm that the work is being done in the required way. In theory they should also send a Quality Control team to check an area that has been declared safe before it is used by the community. UN external Quality Management checks are a rather hit&miss requirement that rarely happens effectively in my experience.

Summary

I have tried to explain humanitarian demining as part of Humanitarian Mine Action while highlighting the differences between military and humanitarian demining. To do that I've written about:

- The required end-result;
- The beneficiaries;
- Marking;
- Detection methods;
- Excavation procedures and tools;
- The uses of machines;
- PPE requirements; and
- Quality Management.

In all cases, military approaches, tools and procedures need to be revised because the end result of humanitarian demining is so different that the procedures used have to be different.

The reasons for doing humanitarian demining are overtly “humanitarian” and the work should always be conducted in support of the wider goals of Humanitarian Mine Action.

One last thing to stress is that humanitarian demining as an “industry” does not have any effective leadership. The main UN agencies involved, UNMAS, UNDP and UNICEF, are often busy with other agenda (which includes competing with each other for funds) and frequently appear to have lost sight of the bigger picture as they strive to respond to immediate needs. GICHD sees itself as a facilitating agency and is not seen as representing the needs of those engaged in the field, so can often be perceived as irrelevant. The donors who could provide leadership and dictate standards usually have a political reason for funding and no comprehensive knowledge of Humanitarian Mine Action. This means that while there is usually a vague general agreement about the goals, there is no agreement about the tools and procedures that should be used or the way that risk should be managed.

Humanitarian demining is all about managing risk. What is a tolerable risk for a soldier is rarely tolerable for a civilian. What is an acceptable level of risk in one post-conflict country may not be in another. And what *was* an acceptable level of risk always changes as the risks tolerated during conflict fade and peace becomes the norm. International humanitarian standards are meant to smooth out the creases and ensure that the work is always conducted to the same high standard, always minimising the risk to deminers and to the people using the land. It does not always happen, but that is the aim.

Ten takeaway points

1. Humanitarian demining should always be conducted with the broader Humanitarian Mine Action (HMA) goal of promoting international human rights values in a post-conflict country.
2. Military demining methods are inappropriate to use when seeking to clear land to the standards agreed in the International Mine Action Standards (IMAS).
3. Relying on ex-soldiers to manage humanitarian demining efforts is not appropriate unless those people have understood and adopted the principles of HMA. Persons without the right approach can unwittingly do great harm to the pursuit of the broader HMA goals.
4. Measuring success in humanitarian demining solely in terms of the land area cleared or the number of explosive devices found is inappropriate because the goals of Humanitarian Mine Action are far broader than that.
5. The need to promote the conditions for transition to sustainable peace and security in a post-conflict context may mean that the fastest or cheapest demining options are not those most appropriate to use. Generally, the most appropriate are those that can be sustainably adopted, managed and executed entirely by nationals within a predictable timeframe.
6. Demining machines alone do not clear ground to the IMAS standard or to any other standard for clearance that would be acceptable in the countries that are paying for humanitarian demining.
7. The promotion of humanitarian values inherent to humanitarian demining requires that every possible measure is taken to reduce risk to deminers and to provide for their long-term needs should an accident occur. Every injured deminer is a burden on the health and welfare system in the recovering country and the loss of a breadwinner is often catastrophic for their extended family.
8. Humanitarian demining should always be part of a cross-agency concerted effort to support the transition of a post-conflict region to a sustainable peace and the adoption of

internationally accepted human rights norms. This should usually include helping to stabilise the national economy by spending as much of the donor's money as possible within that economy.

9. Donors have a responsibility to understand what Humanitarian Mine Action is and to ensure that the humanitarian demining they fund supports the human rights objectives of the Antipersonnel Mine Ban Treaty and the IMAS.
10. As long as wars continue, Humanitarian Mine Action is not a finite activity with an end that will one day be achieved. But it can be successful in one community, one region and one country at a time. Its broad goals were adopted in the interests of the entire global community, not merely the immediate beneficiaries, and can be shown to have helped build the conditions for a sustainable peace in many countries. The process might be faster if the HMA goals were more widely recognised within the humanitarian demining community.