New Technologies and New Ways of Thinking about Mine Action

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Summary

This paper reviews some technologies that have the potential or are already improving the cost effectiveness of mine action, particularly mine and unexploded ordnance clearance. However, technologies by themselves are unlikely to make a huge impact. This paper argues that the best prospects for improving the effectiveness of mine action are more likely to be based on new ways of thinking about the problem and its solutions. These include treating mine contamination as an environmental and health issue, using risk management techniques and statistical process measurement methods and seeking alternative funding sources for mine action. Mine contaminated land is not necessarily wasted: with appropriate management some land could provide useful economic returns before mine clearance. The most important issue is human resource management and training: without building and retaining skills and knowledge none of the advances discussed in this paper are feasible.

New Technologies

Detection

Until recently most experts thought that technological advances in mine detection would provide the best prospects for improving the cost effectiveness of mine clearance. However, six years of intensive research has been devoted to the problem and solutions still seem elusive. Enormous resources have been devoted to research because military agencies have placed countermine technology high on their priority lists.

The current favourite is Nuclear Quadrapole Resonance (NQR) and recent reports suggest that Quantum Magnetics Inc (a US company) is close to demonstrating usable devices. However, the power requirements are enormous and handheld devices suitable for manual demining are said to be five to six years away. The principal technical problem is that TNT, the most common explosive used in mines, is also the hardest to detect using this technique. An NQR detector consists of two devices: a metal detector for initial target location and an NQR sensor to discriminate targets associated with high explosive from metal junk. The NQR sensor needs time to gather its data. The more power available, the less time required to gather and process the data , but the more power available, the more cumbersome the device.

There are also several groups working on improvements to current metal detection technology. These efforts are more likely to lead to affordable solutions. Military researchers are still working on radar, infrared and other technologies but no affordable equipment seems to be on the horizon.

We have recently analysed statistical data from Afghanistan minefields and reached preliminary conclusions that the average time required by a manual deminer to locate a target using a metal detector and investigate it with a prodder is a surprisingly low 2.5 minutes. Note that this is the additional time needed for each target and does not include the time required to scan the ground with a metal detector to search for targets, a lane marking, rest periods and so on. Also, this does not include the time required to cut vegetation, an activity that takes between 50% and 80% of the time in a country such as Cambodia. These findings have important implications for

designers of new mine detectors. If most time is consumed in vegetation clearance, then even the most successful advanced technology mine detector will not make a huge difference to the overall speed of demining work. Also, if an NQR sensor takes two minutes to discriminate high explosive from metal junk, manual demining will still be almost as slow as it is now.

Possibly the greatest advance in the utility of improved sensing technology will come through the combination of mechanised vegetation clearance and an explosive detection technology such as NQR. Machinery like this would lead to major speed improvements in many manual demining operations. However, this also requires major capital investment in new machinery after the sensor technology becomes available for application and that is still a few years off.

Mechanisation

Machines such as flails are increasingly being used to clear vegetation ahead of manual demining teams or mine detection dog teams. The widespread use of flails has helped reduce demining costs by about 50% in Bosnia-Herzegovina and Croatia. They range from small remote controlled robot flails to large machines mounted on tank chassis. Maintenance support for these vehicles is readily available in the region (cost of maintenance support is significant).

In Jordan, flails are being used as an additional risk reduction measure after manual demining. The locations of most of the mines are precisely known since they were laid relative to steel marker posts. However, a proportion of the mines have moved as a result of flooding and erosion, and some have been buried up to half a metre deep.

Although manufacturers claim that their machines can destroy up to 99% of anti-personnel and anti-tank mines there are no operators who are prepared to place this much trust in mechanised mine clearance.

Information Technology

Aerial mapping and survey with remote sensing equipment promises to significantly improve the quality of information available to mine action managers. Aerial photography has provided valuable information in trials over Mozambique. Both satellite and aircraft photography provided useful results on different scales. Satellite photographs revealed changes in vegetation patterns that provided indirect evidence of minefields: local people avoided grazing their animals in known minefields. Aerial photographs provided much more detail and provided evidence of military activity and even tripwires in selected locations.

Military and civilian researchers are now devoting more effort to remote sensing, particularly from slow moving platforms such as air ships. Military planners want to be able to detect and locate surface mines deployed either from aircraft or artillery shells, and infrared and microwave techniques show considerable promise for this problem. Several major research projects in Europe are hoping that this technology will also provide helpful information for humanitarian demining organisations, particularly for locating unexploded cluster bombs in Kosovo. However, there is little evidence that these technologies can confirm the absence of mines.

Better integration of mapping, survey and existing geographic data is beginning to help demining agencies on the ground, particularly in European countries. Experience in the Balkans has shown that older hand drawn maps are far more accurate than intelligence provided from US military satellites. In some parts of Croatia maps prepared for the Austro-Hungarian empire are helping demining agencies today.

Specialised software developed for mine action agencies (IMSMA) is now being supplied to mine action centres in several countries. Once developed to its full capabilities this software will certainly improve mine action planning and reduce training costs.

Mine Detection Dogs

Even though mine detection dogs have been used for humanitarian demining for 10 years it has

only recently become apparent that we have little understanding of their performance capabilities. There was great concern after 80% of dogs failed performance tests in Bosnia late in 1999. A strict testing regime in Kosovo has discouraged companies using mine detection dogs. However, where they can be used dogs have shown that they are by far the most cost-effective mine clearance method. Even in Afghanistan where labour costs are low, mine detection dog teams provide clearance at about one-third of the cost of manual demining teams.

The Geneva International Centre for Humanitarian Demining has recently initiated a major study of mine detection dog performance. They have planned a testing program extending for at least two years in Afghanistan. It is hoped that this program will tell us more about mine detection dog performance and factors that affect it.

Hand Tools

A new range of high powered hand tools could provide significant performance improvement in specialised situations. For example mines laid in and around the ruins of mud brick houses (a common scenario in Iraq, Iran and Afghanistan) are usually found buried deep in hard baked mud after years of erosion. Remotely operated jacks can significantly improve the rate at which deminers excavate these areas.

New Ways of Thinking

The initial approach to the landmine problem was to train and deploy demining teams as quickly as possible. In Afghanistan, for instance, demining started in 1989 and by 1993 about 2500 deminers were working in the field.

Between 1996 and 1998 there was a major shift towards integrated "mine action" programmes with coordinated survey, victim assistance, mine awareness training and mine clearance operations.

Recently there has been more emphasis on "socio-economic evaluation and planning" and a call to integrate mine action programmes more closely with other redevelopment activities. In practice this has already occurred in several mine action programmes where there has been good cooperation and communication between mine action agencies and other redevelopment organisations, such as in the Balkans and Afghanistan.

However, it is now apparent that further changes can lead to major improvements in global efforts to eliminate landmine problems as an obstacle to post-conflict recovery.

Epidemiology and Environmental Health

The United Nations Mine Action Service recently completed a major survey of landmine problems in Yemen. Detailed statistics were gathered on the impact of mines across the entire country showing how many people were being killed and injured and which land areas were out of use because of mine threats. Unfortunately very little information was collected on other health problems faced by these populations.

Even though Lebanon is only just beginning to deal with its major mine problem, their approach may be more soundly based. The Landmine Resource Centre in Beirut has conducted an epidemiological study which sets the health risks posed by mines and unexploded ordnance in context with other health problems faced by the affected communities.

Our own interviews with people in mine affected parts of Cambodia revealed that even in the most severely contaminated regions disease posed a much greater risk to human health than mines. Much of this disease could be prevented by improved drinking water supplies, sanitation and education.

Faced with limited resources, national governments need to consider the landmine problem as just one of the environmental and health problems faced by their population. Improvements to

public health can be obtained by investing in several other alternatives: improving water supply, better sanitation, local health clinics, immunisation programmes and malaria prevention measures. In most of the countries we have visited for our research, landmines posed a relatively small risk compared with other hazards and this might explain why it is often difficult to persuade national governments to provide significant resources for mine action.

In contrast, populations in western countries see the landmine problem as a major "humanitarian disaster". Aid funds are collected to provide immediate humanitarian relief for particular groups of people, often as a result of exposure in mass media. This leads to significant differences in perception and priorities once operations start in the affected country.

Risk Management

United Nations standards for mine clearance have been reviewed over the last 12 months and draft proposals for new standards will soon be available for comment. Our own research has shown that the requirement for 99.6% clearance to a depth of 20 cm is unrealistic and unmeasurable. The new standards will emphasise risk management and require mine action agencies to set realistic performance levels taking local conditions into account.

One of the conclusions of our research using data from Afghanistan is that it is possible to set quantitative limits on acceptable contamination levels. We know that Afghan populations accept current levels of clearance achieved by manual demining and other methods. We also know that the same populations avoid using land with significant mine and unexploded ordnance contamination. Data from clearance operations in these areas allows us to quantify "unacceptable" contamination levels. We have developed quantitative methods to measure clearance levels achieved by manual demining and these allow us to estimate the residual contamination level after clearance.

With a combination of local knowledge, accurate survey and experience from manual demining operations mine clearance agencies can quantify mine contamination levels in advance of clearance operations. In areas of low contamination and appropriate ground conditions mechanical clearance can still provide acceptable performance even though it is far from 100% effective. A flail will detonate a proportion of the mines it encounters and this serves as an additional indication of mine contamination level. Mechanised clearance can significantly reduce demining costs and, more importantly, results in faster clearance. By making land available sooner, the cost effectiveness of mine clearance is still further improved.

Quality Measurement

Most mine clearance organisations check mine clearance quality by repeating clearance operations in part of the area that has been cleared. Our research has shown that this kind of post-clearance sampling cannot confirm clearance quality to the acceptable contamination levels that we deduced from Afghanistan data.

In areas where metal detection is used and all the metal is removed from the minefield, post-clearance checks can reveal where clearance has been unsatisfactory. However it is not easy to understand why these clearance performance problems arise in the first place.

To overcome these problems we have devised in-process methods for measuring the quality of manual mine clearance operations using cheap and simple equipment. Small metal targets are placed in known locations in advance of demining teams though the deminers themselves do not know where the targets have been placed. The deminers recover the targets during clearance. The number of targets recovered quantifies the clearance performance of the demining team.

Occupational Health and Safety

Accidents during mine clearance operations still pose a significant threat to the safety of deminers. However, recent experience in Afghanistan shows that accident rates can be

significantly reduced to levels comparable with acceptable "western" norms. The largest Afghan demining agency, ATC, has almost managed to eliminate accidents for extended periods of time. Across the whole program accident rates have been reduced by 75% in two years. Surprisingly many of the improvements devised by the Afghans closely mirror "best practice" in industrialised countries with an emphasis on changing corporate culture.

Alternative Funding Models

Mine action programmes are often supported almost entirely from humanitarian aid funding. In countries where there is significant local participation it is mostly in the form of manpower provided by military or paramilitary agencies such as the police.

One of the reasons for this is that governments in mine affected states typically have a very weak hold over their economies. The political unrest that accompanies conflict often persists long after armed conflict has stopped. State institutions remain weak and ineffective and are often unable to provide effective services or collect of taxes. Therefore, it is unrealistic to expect governments in these states to maintain significant participation in mine clearance and other reconstruction efforts.

Micro credit has proved to be a worthwhile method for improving the economies of local communities. We have investigated the possibility of using micro-credit as the method for providing alternative funding for mine clearance operations. There are many difficulties, not the least of which is a relatively high overhead cost resulting from the large number of small loans provided. However, there are also many advantages, particularly as communities learn to manage their own financial affairs.

Provided a micro- credit scheme can raise sufficient input funds to cover overhead costs then the total amount of funding available for mine action will be increased in the long-term. Further, local communities will exercise more control over demining operations once they have financial participation and this is likely to result in significant improvements in effectiveness.

Alternative Land Use

Most mine action programmes work on the assumption that mine contaminated land is useless. In some countries, vegetation recovered during mine clearance is made available for local communities as fire wood but the land provides no return until mine clearance is started.

In South Africa and other countries engineers have developed a range of mine resistant vehicles. Anti-personnel mines have minimal impact. Anti-vehicle mines will usually destroy one or more wheels but the vehicles are designed to be repaired and operating within a few minutes. In areas where a anti-vehicle mines are likely mine resistant vehicles are usually deployed in pairs to reduce the risk that a crew will become stranded.

As modern forestry operations are almost completely mechanised, from tree planting to thinning and eventual harvesting,, it is possible in principle to conduct forestry operations in mine contaminated areas by providing appropriately equipped mine resistant vehicles.

We are currently researching the likely costs and benefits of mechanised forestry operations in mine contaminated land. One attractive possibility is to encourage countries that have high carbon emissions to invest in mine resistant forestry machines and create plantations on mine contaminated land in other countries. These forestry developments will need to be carefully planned to ensure that the needs of local inhabitants are also provided for. However, the long-term economic returns could be very significant particularly as the need for mine clearance can be deferred perhaps indefinitely.

Conclusion: Human Resource Management

In this paper I have explained how new technologies can provide improvements in mine action, however the effectiveness of these improvements depend on new ways of thinking about the

mine problem. Far from being a simple activity where deminers probe the ground looking for mines, mine action is evolving into a complex series of activities closely integrated with other reconstruction activities. Given that resources are limited we have to be careful to ensure that maximum benefit is obtained.

All of the developments I have mentioned in this paper require highly developed skills to be used effectively. Therefore, the most important component of effective mine action has to be human resource development.

Some people have claimed that it is easy to train people to be deminers -- a two-week course is quite sufficient. Experience in countries like Afghanistan has shown that this is far from the truth. It takes years to develop effective demining organisations and extensive training is required at all levels. It is useful to compare mine action in countries that use conscripted military personnel with programmes using civilian organisations with long-term employment contracts. The long-term employment and training is essential for cost effective demining and high safety levels. Deminers must understand a much broader range of skills than using a metal detector and prodding for mines. They must learn how mines were used to be able to spot hazardous situations. They must learn communication and supervision skills so that they can become supervisors when required. They need to understand how to monitor their own performance and how to ensure maximum levels of alertness while working. Supervisors need training in team management, communication skills, data recording and quality management techniques. Staff at all levels need language skills: often they will be working with people who do not share the same mother tongue.

Further Reading

Recent reports on most of the topics mentioned in this paper can be obtained from the Demining Research Project at The University of Western Australia, available at http://www.mech.uwa.edu.au/jpt/demining/reports.html.

For further information on detection technologies, refer to the DeTec Project web site at the Swiss Federal Polytechnic at Lausanne. See entry at http://www.mech.uwa.edu.au/jpt/demining/links.html.

The Journal of Mine Action contains articles on many of these topics at http://www.hdic.jmu.edu/ and this site also provides links to the on-going review of UN mine action standards.

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