GROUP OF GOVERNMENTAL EXPERTS OF THE STATES PARTIES TO THE CONVENTION ON PROHIBITIONS OR RESTRICTIONS ON THE USE OF CERTAIN CONVENTIONAL WEAPONS WHICH MAY BE DEEMED TO BE EXCESSIVELY INJURIOUS OR TO HAVE INDISCRIMINATE EFFECTS

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Working Group on Mines Other Than Anti-Personnel Mines

<u>Current and future technology for MOTAPM detection and clearance</u>

Presentation prepared by the United Nations Mine Action Service (UNMAS)

Introduction

1. Throughout 2003, the United Nations Mine Action Service (UNMAS) prepared presentations illustrating the practical problems that occur when clearing mines other than anti-personnel mines (MOTAPM). During the discussions of this issue in the GGE, the question was raised whether or not in the near future clearance techniques could be available to humanitarian mine action actors to replace the commonly used metal detector. In order to assist delegates in their deliberations, UNMAS has prepared the following report on current and future techniques for MOTAPM detection and clearance, highlighting their strengths and limitations with consideration to the requirements for humanitarian mine clearance.

Requirements for humanitarian mine clearance technology

2. Humanitarian mine clearance actors face minefields with different types of mines (anti-personnel, anti-group, anti-vehicle, also UXO) in different types of landscapes and climates. An acceptable clearance technology has to be able to deal with most types of mines in most types of landscapes under sometimes-difficult environmental conditions.

3. The local personnel available to mine action programmes in post conflict areas mostly have no higher school education. The clearance technology used, therefore, needs to be as simple and easy to handle as possible.

4. At the same time, and in most cases, there are no adequate logistic supply systems available in post conflict areas. The clearance technology used, therefore, should not rely on sophisticated spare parts or on high-level maintenance skills. It needs to be robust enough to remain operational in dusty or muddy environments, as well as in areas where power supply is hardly reliable.

5. The clearance technology should be reliable and achieve a clearance rate of 100%.

6. The clearance technology applied should be cheap, because the funds available to humanitarian mine action are very limited. This fact is unlikely to change in the near future.

Overview of current and future technology for MOTAPM detection and clearance

7. As mentioned above, there are various requirements for a technology matching the needs of humanitarian mine clearance, especially for the clearance of MOTAPM. Research in the field of mine detection and clearance technology has been carried out for the last 75 years, especially by the military, with large sums invested in it. The table below gives an overview of techniques that may be applicable for mine clearance. Their operating principles are briefly described as well as some comment on their potential for humanitarian mine clearance.

Technology	Operating Principle	Strengths	Limitations	Potential for Humanitarian Mine Clearance
Electromagnetic Detection				
Electromagnetic induction	Induces electric currents in metal components of mine	Performs in a range of environments Easy to handle, robust, cheap Operates with commonly available batteries	MOTAPM with low metal content are difficult to detect; consequently clearance is expensive and time-consuming, the likelihood of missing a mine is increased. Many false alarms, especially in areas with metal clutter, like former battlefields. MOTAPM fitted with anti-handling devices or sensitive fuzes present a danger to deminers.	Established technology. Incremental improvements to detect metal are possible but this technique is unlikely to be able to detect “mines” with confidence. False alarm rate will remain. Further improvement only possible with computer based high-technology which is expensive and difficult to handle.

Ground-penetrating radar	Reflects radio waves of mine/soil interface	Detects all anomalies, even if nonmetal	Performance negatively affected by roots, rocks, water pockets, other natural clutter; extremely moist or dry environments Better suited to detect layers than specific objects Higher costs than metal detectors More difficult to handle than metal detectors	GPR as stand-alone system does not currently provide the clearance reliability required.
Electrical impedance tomography	Determines electrical conductivity distribution	Detects all anomalies, even if nonmetal	Performance negatively affected in dry environments; can detonate a mine, too expensive and complicated	Unlikely to yield major gains
X-ray backscatter	Images buried objects with x-rays	Advanced imaging ability	Slow to give indication; radiation is emitted; expensive and complicated to operate	Unlikely to yield major gains
Infrared/hyperspectral	Assesses temperature, light reflexion differences	Operates from safe standoff distances and scans wide areas quickly	Cannot locate individual mines. Very limited against buried mines	Not suitable for close-in detection. Unlikely to yield major gains
Combined systems	Electromagnetic induction combined with another sensor e.g. GPR and/or infrared	Combination of strengths above mentioned. Could reduce false alarm rates	High costs Triggered by metal indications therefore has the same limitation as for electromagnetic induction but with possibly fewer false alarms.	Field tests are still being conducted and a system has been fielded in operational conditions. Has some potential.
Acoustic / Seismic Detection	Reflects sound or seismic waves of mines	Low false alarm rate	Not reliant on electromagnetic properties; problems with deep mines, vegetation cover, frozen ground High costs and possibly difficult to operate	Only promising if limitations can be worked out.

Explosive Vapour Detection				A technique for area reduction more than clearance. The precise location of mines and UXO still needs to be done with the help of some other technique.
Biological (dogs, bees, bacteria, rats, pigs, etc)	Living organisms detect explosive vapors in situ.	Can confirm presence of explosives	Problems in dry environments; affected by high vegetation, windy, very cold or hot weather; demanding logistic support; night activity (rats)	Basic and continued research needed to determine full potential (though dogs are widely used today)
Remote sensing	Sampling of explosive vapour with filters, which are then presented to dogs or some other sensing animal or device, away from the affected area.	Faster than traditional use of dogs Reduces logistical efforts as the samples are brought to the sensor. Have a high potential for area reduction	Difficult to operate due to variables; Reliability; Training requires experienced staff; To be used only under certain environmental conditions; Susceptible to false alarms Expensive and only area reduction tool.	Continued research needed to determine full potential. Area reduction tool, which cannot be used to locate the position of a single mine. In use today.
Flourescent	Measures changes in polymer flourescence in presence of explosive vapors	Confirms presence of explosives	Performance negatively affected in dry environments	Basic research needed to determine operational potential
Electrochemical	Measures changes in polymer electrical resistance upon exposure to explosive vapors	Confirms presence of explosives	Performance negatively affected in dry environments	Basic research needed to determine whether detection limit can be reduced

Piezoelectric	Measures shift in resonant frequency of various materials upon exposure to explosive vapors	Confirms presence of explosives	Performance negatively affected in dry environments	Basic research needed to determine whether detection limit can be reduced
Spectroscopic	Analyzes spectral response of sample	Confirms presence of explosives	Performance negatively affected in dry environments	Basic research needed to determine whether detection limit can be reduced
Bulk Explosives Detection				
Nuclear quadrupole resonance	Induces radio frequency pulse that causes the chemical bonds in explosives to resonate	Identifies bulk explosives	Problems with TNT and liquid explosives detection; limited use in areas with radio frequency interference or quartz-bearing and magnetic soils	Many mines contain TNT, unworkable if system cannot detect this explosive
Neutron based technology	Induces radiation emissions from the atomic nuclei in explosives	Identifies the elemental content of bulk explosives	Not specific to explosives molecule; performance negatively affected in moist soil; ground-surface fluctuations	Unlikely to yield major gains
Advanced Prodders / Probes	Provide feedback about nature of probed object and amount of force applied by probe	Could deploy with almost any type of detection method	Hard grounds – like roads, where most MOTAPM are found, roots, rocks; requires physical contact with mine; Time-consuming. MOTAPM fitted with anti-handling devices or sensitive fuzes present a danger to deminers.	Only promising for specific areas.

Mechanical Clearance Systems			Mechanical clearance systems that can deal with MOTAPM have high operational and maintenance costs	Mechanical systems may not break up the hard ground (flails) or if they have the potential to do so, such as the powerful tiller systems, they destroy the structure of the road and leave light dust behind which causes problems to manual deminers and dogs doing the verification behind the machine.
Mini Flail (up to six tons)	Activation of mine through rotating flail	Easy to transport Suitable for ground preparation	Should not be considered as stand alone clearance asset. Can neither be used on hard topsoil (Afghanistan) nor on roads Depending on soil conditions, systems leave light dust behind the machine, which causes problems for manual deminers and dogs conducting verification behind the machine. Designed for AP mine clearance only. Remotely controlled, systems cannot be operated with precision from greater distances.	Established technology, but not suitable for MOTAPM.

Medium Flail (6-20 tons)	Activation of mine through rotating flail	Suitable for ground preparation Can withstand a MOTAPM detonation, but flail unit might be damaged to a certain extent.	Should not be considered as stand alone clearance asset. Can neither be used on hard topsoil (Afghanistan) nor on roads Depending on soil conditions systems leave light dust behind the machine, which causes problems to manual deminers and dogs doing the verification behind the machine. High acquisition and running costs.	Established technology, but too many limitations to be widely used by humanitarian actors.
Heavy Flail (20 tons and more)	Activation of mine through rotating flail	Can withstand a MOTAPM detonation without serious damage both to the vehicle and the flail unit. Can be used on hard topsoil Suitable for ground preparation	Should not be considered as stand alone clearance asset. Can be used on hard topsoil, however penetration depth is significantly reduced. Depending on soil conditions systems leave light dust behind the machine, which causes problems to manual deminers and dogs doing the verification behind the machine. High purchase and running costs. High logistical effort and transportation problems.	Established technology, but too many limitations to be widely used by humanitarian actors

Tiller	Activation or destruction of mine through rotating tiller-drum	Are designed to withstand most MOTAPM blasts. Can be used on hard topsoil. Better penetration depths in all soil conditions due to powerful engines. Suitable for ground preparation	Should not be considered as stand alone clearance asset. Requires highly qualified mechanics and operators. Depending on soil conditions systems leave light dust behind the machine, which causes problems to manual deminers and dogs doing the verification behind the machine. High acquisition and running costs. High logistical effort and transportation problems.	Established technology, but too many limitations to be widely used by humanitarian actors
Multi-Tool	Multi tools are fitted with a series of optional attachments such as flails, disc rollers or digger-buckets	Versatility Mostly based on commercial excavators, which facilitates the access to spares	Designed for AP mine clearance only Do not normally operate in minefields, but from the edge which reduces productivity.	Established technology, but not suitable for MOTAPM
Sifter	Systems aim to separate mines or parts of mines from the previously treated topsoil		Reliability is not yet proven Can only operate in certain environmental conditions (dry, sandy areas)	Established technology, primarily used as a quality assurance tool only, not MOTAPM clearance

Conclusions

8. Despite significant investment in technology research and development, metal detection, dogs and machines are still the most applicable options for humanitarian mine clearance. New techniques at present do not promise quick results, if at all. They all have some strengths, but many limitations for the clearance of MOTAPM. Most of them remain at a prototype stage and their use in the field is not yet foreseeable. No single technique provides a “silver-bullet solution” for all minefields and clearance requirements. Thus only combinations could make up a workable option. These may be too expensive and too complicated to be used in humanitarian mine clearance.

9. At some stage all techniques applied to the clearance of MOTAPM require manual support. When clearing MOTAPM manually, it needs to be considered that MOTAPM fitted with anti-handling devices or sensitive fuzes such as tripwire, breakwire and tilt-rod present an unacceptable risk to deminers.

10. In summary, it can be said that research and development cannot yet fulfil all the requirements of the humanitarian demining user community. There are no simple or cheap solutions for mine clearance, if all factors relevant for humanitarian mine clearance are considered. At the same time, the impact of MOTAPM on local populations and aid workers in post-conflict areas has been demonstrated by UNMAS in previous presentations. Current clearance technology developments are only part of the solution, specific changes to the design of MOTAPM themselves would be the real key to solve the MOTAPM problem.

Recommendations

11. Therefore, in order to limit the humanitarian impact of MOTAPM, to ease the work of post-conflict mine clearance operations and to make sure that our generation does not produce problems that future generations can not solve adequately, the following should be adopted:

- All MOTAPM, should contain a self-destruction mechanism, or at least mechanisms for self-neutralization or self-deactivation so that they have a limited lifespan.

- MOTAPM should be detectable by commonly available technical mine detection equipment.

- MOTAPM should not be fitted with anti-handling devices.

- MOTAPM should not be fitted with sensitive fuses that can be activated by the presence, proximity or contact of a person.

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