Spoiled Soil

While it is necessary to remove explosive items from the land to facilitate repatriation, reconstruction and rehabilitation, it is crucial that in undertaking this action, the soil structure is not inadvertently damaged, creating short, medium and long-term problems for agriculture and the sustainable farming that supports vulnerable communities.

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Introduction

Over the last few years, the increased use of mechanical equipment for humanitarian demining has demonstrated that it can not only improve the safety of hazardous work, but can also vastly improve clearance productivity and effectiveness. By adopting an integrated approach, incorporating manual clearance and explosive detecting dogs (EDDs), operational managers can select the best combination of methods to suit the wide variety of sites and environmental conditions.

Taken individually, management of these three methods (manual, EDD and mechanical) requires very different skills, experience and knowledge. The level of knowledge and skills necessary for the effective management of manual demining teams can be easily achieved, especially by ex-military engineers with relevant explosives and managerial experience. The knowledge and management of EDDs is much more difficult to obtain, for many managers have little or no prior experience with dog use or dog management and must learn "on the job." Poor management of these two methods may well affect the overall performance, quality and safety of the clearance operation, but it does not affect the long-term condition of the ground.

However, the lack of understanding of the wider aspects of the use of mechanical clearance equipment has the potential to create considerable additional problems for the future while assisting in solving the mine contamination problem. Considerable damage can be inflicted on fragile soil texture by the inappropriate application of mechanical methods changing the soil properties. Although some personnel may have a "general" knowledge of vehicles, few will have undertaken formal training in equipment management, and the vast majority will have no knowledge of or experience with soil management. It is therefore not surprising that some demining equipment designs, utilisation and supervision, when measured against the principles of agricultural soil management, could be having a disastrous effect on landmine clearance.

While the use of manual and EDD assets for the removal of munitions will not damage the ground, poor equipment design and/or the inappropriate selection and use of mechanical assets can cause temporary, and in many cases irreversible, damage to the structure of the soil. A wide range of variables can affect soil fertility, drainage, rooting potential and water holding capacity. Mechanical damage may also initiate, or accelerate, topsoil erosion, creating problems that will affect vulnerable populations long after the clearance task has been completed. Since a primary function of most clearance tasks is to return land for resettlement, the methods used should not have a negative impact on subsequent land use, grassland or arable land, or reduce the future sustainability of agriculture.

Soil Erosion

Degradation of soil quality, in particular topsoil depth and soil texture, will markedly reduce the land's capability to grow crops. Soil degradation will increase vulnerable soil susceptibility to wind and water erosion, which will further limit land use and cropping potential in the short, medium and long-term. Structural degradation of heavier soils will result in increased water-logging due to drainage limitations. In addition, damage to vegetation cover, including the roots, can have negative effects, further contributing to soil erosion.

While the damage that mine clearance equipment causes globally is small in comparison with other soil erosion activities, it is primarily concentrated in local, economically important and sometimes critical areas, such as fertile agricultural or sustainable farming terrain. It is therefore imperative to facilitate understanding of the damage that could be caused by such equipment, whether it is temporary or permanent, and what action should be taken to minimise damage and improve soil management.

When undertaking the function of removing hazardous material such as bombs and mines, it is necessary that any organisation using mechanical equipment ensure that the essential soil structure (including natural and artificial drainage features) is left undamaged. While the destruction of munitions will cause some damage to soil properties, this is not considered to be a major factor.[1] Poor soil quality—including desert conditions supporting limited indigenous plant and wildlife, land suitable only for the grazing of sheep, cows and goats, or land with very shallow topsoil—can be extremely sensitive and easily damaged beyond repair simply by the use of wheeled vehicles.[2] Even good quality soils can be temporarily or permanently damaged by any vehicle use that results in increased soil smearing, compaction and cloddiness.[3] When considering the selection and use of vehicles, especially in sensitive soil conditions, it is essential that the primary objective should be the prevention of unnecessary damage to soil properties.

Equipment Design

It is rapidly becoming apparent that some mechanical equipment has already been utilised in a manner that has caused excessive soil damage. The major reasons for this are:

- **Working element.** A lack of technical understanding available to assess and analyse soil mechanics relating to soil movement, stress regimes and soil particle inertia.
- **Equipment design.** Many of the currently available mechanical equipment is based on wheeled or tracked vehicles, or excessively heavy machines (including Main Battle Tanks) that use flail, mulching or grinding attachments to remove vegetation by impacting the ground surface. This presents three implementation problems:

1. Selecting of tyres or tracks that will mitigate compaction and smearing.
2. Ensuring that operations are conducted in an appropriate manner, on suitable ground and soil conditions, taking into account seasonal limitations and weather conditions.
3. Ensuring that the implement utilised to remove or disrupt soil (in an attempt to locate and destroy munitions) does not cause compaction, smearing or soil profile mixing.

- **Inappropriate selection and/or use of the equipment.** This can include selecting the wrong type of equipment for the localised conditions, use in excessively wet soil conditions, in areas beyond the effective capability of the equipment, or in sensitive terrain or soil conditions where the mechanical action will damage or destroy the fragile soil structure, irrigation systems, etc. The outcome of such use may result in topsoil damage, erosion or decreased soil fertility. There is also no required assessment procedure to be performed prior to the selection of vehicles/equipment.
- **Lack of technical knowledge.** The majority of personnel (operational or managerial) who are involved with the use of mechanical equipment have no formal training in its field use, or in soil management. It is therefore not surprising that mechanical clearance activities in unsuitable soil conditions are frequently undertaken. It is also not surprising that the potential for creating future problems is neither appreciated nor understood.
- **Understanding of soil management.** It is believed that to date no formal course on soil management has been undertaken anywhere in the Balkans region for inspectors, monitors, operational managers, team leaders or even mechanical equipment operators. This statement probably applies to the majority of programmes worldwide.

Trafficking, Cultivation and Soil Damage

Based on the reasons outlined above, it is not surprising that mechanical equipment is being utilised with little or no consideration of the potential damage that can be unintentionally caused. Whereas the agricultural community is extremely careful about the utilisation and management of equipment, not creating situations that will damage, pollute or erode the soil, available evidence indicates that the same cannot be said about the mine action community.

To date, there appears to be no attempt by the mine action community to ensure the correct selection of suitable tyres and operational procedures that would reduce compaction and other soil damage. There is aslo no evidence that, by design or implementation, organisations actively address such issues as inflation and deflection, ply rating, tyre construction and traction aids, forward speed, loading tyre lugs and tyre profile. Despite the fact that many machines are tracked, the sheer weight of some of them will, in poor soil structure and thin soil profile, cause serious and long-lasting damage. In addition, there is no evidence that organisations plan their operations in a manner that would minimise soil damage or that they take remedial measures to restore any damage they have caused to the soil after the area has been cleared.

While soil damage can be caused by the wheels of clearance vehicles, the vast majority of the damage is caused by the action of the clearance device when it is utilised to disrupt the soil to a defined depth. In Bosnia-Herzegovina and Croatia, this depth is defined by the national regulations as 10 cm. This regulation takes no account of topsoil depth, which may be considerably less, or of damage to the underlying subsoil.

Damaging Topsoil and Subsoil

A number of methods are utilised to disrupt the soil to depths in excess of 10 cm. These include ploughs, rakes, flails, and mulching and milling machines, with the most common being the flail. Flail machines used to "dig" to stipulated depths not only disrupt the soil; they can also cause compaction of the soil at depth. Disrupted soil can be further compacted by the host vehicle that houses the flail unit, now operating on top of a soft soil surface (compacted underneath), compacting a second layer on top of the first. However, if soil has to be disrupted, the use of chains is by far the most inefficient method of providing a digging implement. The physical act of digging with heavy chains and swing weights pulverises the soil, while at the same time compacting the ground below the disrupted surface. Milling machines cause massive compaction, as does the "bellying" of any heavy equipment while operating. Wheeled machines generally cause considerably more compaction than vehicles that have tracks to spread the load. While all these actions cause damage, the pulverising or compaction of the soil resulting from the requirement to dig to stipulated depths can, in certain environmental conditions, compound that damage.

Mechanical Equipment Regulations

A number of mine action centres (MACs) have produced regulations addressing the depth to which mechanical equipment must "dig"; for example the Mechanical Preparation of Ground, (part of Bosnia-Herzegovina's MAC Standards), and their Instruction for Technical Survey. While the figure required is stated as 10 cm, the variety of mechanical equipment and ground factors means that the actual figure achieved could often be considerably more. It can of course also be less, but as the regulation stipulates 10 cm, organisations will tend to disrupt soil to a

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greater depth in order to ensure compliance.

Manual deminers use prodders and metal detectors and may be assisted by EDDs, but neither the detector nor the EDDs disturb the soil. While manual clearance and EDDs are accepted as "stand alone" clearance methods, machines are not. In many programmes, the use of machines requires subsequent checking by men or EDDs to achieve clearance quality standards; that being the case, and accepting that soil damage is a serious issue that may negatively impact vulnerable communities, it raises the question of why programme authorities demand that machines must disrupt the entire soil surface, regardless of soil conditions.

While it is accepted that the disturbance of the soil by mechanical equipment can increase safety, productivity and cost-effectiveness, only appropriate designs of machine, operated correctly and only used in suitable conditions that allow disturbance without soil damage should be utilised.

Conclusion

There is no question in the minds of the agricultural specialists that damage is being caused by the use of mine clearance vehicles, but the full extent of this damage and the reasons for the damage—poor management, inappropriate equipment utilisation, incorrect procedures, etc.—need to be scientifically assessed. It is also recognised that the use of mine clearance vehicles can improve safety and productivity. Therefore, the dual requirements of removing hazardous material without causing unnecessary damage to the soil structure have to be integrated. The international demining community must ensure that in undertaking clearance activities, the soil structure is not inadvertently damaged, creating short-, medium- and long-term problems for agriculture, in particular to sustainable farming that is vital to the support of vulnerable communities. International standards should reflect the necessity to protect the environment while undertaking mine action activities. ■

Endnotes

1. In the cases of munitions explosions, the issue of chemical soil contamination should be considered, particularly in and around the hot zone. In many cases, the amount of explosions (a few AP mines for example) makes this a minor problem; however, in cases where mass demolitions are being conducted (such as stockpile destruction), consideration is necessary.

2. While many types of equipment have tracks, giving a greater spread of the vehicle weight, a large number of vehicles used worldwide are wheeled. The weight of clearance vehicles can range from two to 56 metric tons.

3. Smearing - the spreading and smoothing of soil particles by sliding pressure.
Compaction - the effect of wheels or tracks (or vehicle attachments) causing compression of the soil particles, closing the pore spaces that act as pathways for water, air and roots.
Cloddiness - the result of compaction of heavier-textured soils where particles bind together to form structureless clods.

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