ABSTRACT

This paper relates a Demining Manager’s view on the shortcomings of current demining techniques and technology and how satellite imagery might secure improvements. The process of gathering information for a mine action task is used to indicate actions required before imagery is acquired. The key is seen to be historical benchmarks to determine pre combat and combat periods. Possible clues to the presence of minefields are suggested.

INTRODUCTION

Humanitarian demining is active and producing welcome results, it could do better.

War feeds demand.

In this paper the limitations, and thereby the need for improvement, are studied to illustrate where Image Information Mining might help.

The views expressed are personal and those of a User. Time only permits discussion in general terms. Detail can be furnished subsequently should it be required.

DEMINING TODAY

Risk

Landmines and unexploded munitions can kill or maim and damage equipment. Safety is a predominant factor for Deminers to protect life. The hard economic fact is that damage and injuries cost time and money. Thus advances in protection and safety are urgently sought to improve cost effectiveness.

Indicators

Some military make records of minefields, terrorists do not. Unexploded munitions are evident by their presence, holes or hardware. Sadly, the most common indicator for mines and munitions is casualties to people and vehicles. The International Mine Action Standards (IMAS) criteria for establishing priorities for mine action are based on the number and location of casualties. Thus advances in the location of hazards could prompt preventative action and thereby circumvent casualties.

Means

Demining involves money, manpower and machines.

Money. To mobilise, equip and deploy demining teams costs money. The extent of the demining operations is limited by the cash available. Thus advances in the efficiency and speed can help extend the span of available resources.

Manpower. Recent demining operations have meant that there is a pool of trained Deminers in the world. Many are from underdeveloped countries and their lower wages and tenacity to work for long periods on routine tasks in harsh climates, make them economically attractive.

There have been shortcomings in the availability and quality of demining team leaders. However, good training and experience of the less educated Deminers from underdeveloped countries have produced some sound managers. Today, the expensive ex pats are attracted to the rich rewards in Iraq.

Machines. Technology and tools might be a more accurate description. Not a lot has changed in the past 70 years with regard to technology. There is talk of ground penetrating radar and combination detectors. They may be available to the military but humanitarian Deminers still search for a new cost effective field tool. The enlightened combination of manual demining teams, mine detection dog teams and mechanical demining teams for reconnaissance, mine clearance and quality assurance provide the optimum resource of today. Improved performances have been achieved with peripherals such as improved batteries, new and improved materials giving better reliability and handling, worldwide communications with sat phones and e-mail and recording procedures, databases and operating standards with IMAS.

Major Inefficiency

The major waste of resource today is the time and effort dispensed on looking for mines and munitions where they do not exist. Deminers would like to focus...
on areas where there are known contaminations. Days are lost on surveys searching until a contact is made. Haste can mean casualties. Even in a marked and recorded minefield there are large areas between the mines and mine rows with no contamination and time has to be spent defining these areas with teams on the ground. Records are not the complete answer as remotely delivered munitions and unexploded artillery and air delivered weapons could also be around. Thus advances are urgently sought to locate the presence of contaminations, reliably and accurately.

Summary

In summary, Deminers seek the accurate location of mine free and contaminated areas to focus their work thereby to reduce the risk of casualties, to improve performance and to extend the areas cleared in the available time with the available resources. In essence, they seek improvements in safety and cost effectiveness.

THE THREAT

The threat is from mines, unexploded munitions and booby traps.

Mines

Mines may be laid in a minefield or used individually to attack a specific target or hinder access to an area. They may be anti personnel or anti vehicle mines in a range of sizes with a variety of fuses and sensors.

In a minefield, mines are normally laid to a pattern, fenced and marked with records made of the locations of markers, rows and boundaries and the numbers and types of mines.

A small number or individual mines may be laid to deny the enemy moving on a particular track or road, or to reinforce a defensive feature such as a river crossing.

Unexploded Munitions

These are mines, bombs or artillery shells that have not detonated but remain a threat on or in the ground. They can be found anywhere in a combat area and also inside fenced minefields.

Booby Traps

These are used to deter the enemy with the threat of injuries to individuals or small groups of persons. They can be found on a tracks, behind cover or in buildings. Anywhere where it is likely that people will pass or enter. They may be planted in minefields to harass the Deminer.

Initiation

Mines and booby traps are usually initiated by the foot of a person or the wheel or track of a vehicle. However, initiation may be by magnetic or heat signature or remote control. Thus the remote detection and location of hazards from satellite imagery will aid safety.

PURPOSE OF MINEFIELDS AND BOOBY TRAPS

It is important for the Deminer to know the purpose of minefields and booby traps to help understand the enemy and what they may be doing in the area. Each minefield or booby trap will have a specific purpose. The layer will have selected the type or combination of munitions to achieve his aim in a location that has a high probability of engaging a target.

Tactical minefields are employed to reinforce the terrain. They are use to exploit natural features that deny or slow the movement. Typical features that hinder movement are steep slopes, buildings, marshy areas, lakes, rivers and wooded areas. Thus by linking the natural barriers with minefields, the enemy may be blocked or diverted so that the defender can buy time or bring his weapons to bear on the enemy, more effectively.

Protective Minefields are used to reinforce the defence of a particular position or feature such as a bridge or important road junction. Infantry positions may be protected by anti personal mines to slow an enemy in closing onto a position for hand to hand combat. In the heat of battle such small minefields are seldom recovered or recorded.

Booby traps are also used to hinder and kill the enemy thereby distracting him from closing with the defender.

INFORMATION AVAILABLE

The Deminer seeks information from all available sources to achieve the best possible indication of the contaminations present. The course followed to acquire information will depend on the resources available in the country and/or area of interest. The first step would be the National Demining Office (NDO), if there is one. Next is the Mine Action Coordination Centre (MACC), if there is one. Local Police, the Military, NGOs, Local Authorities and the local residents are all potential sources of information.
In areas where Mine Action operations are underway, the NDO and MACC are likely to operate IMSMA. The system produces excellent maps. IMSMA is sponsored by the United Nations and the Geneva International Centre for Humanitarian Demining (GICHD) but is not available in all countries. It may not be operational or populated with reliable information. Elsewhere offices are likely to hold marked maps, minefield records, photographs (satellite, air and ground) and simple sketches and lists. Hospitals and Humanitarian Agencies will have casualty statistics.

National and State agencies operating IMSMA are likely to hold data banks and details of known contaminated areas, mine action assessments and survey reports. Demining NGOs and Companies could be actively employed on surveys and assembling information in readiness for clearance operations.

MINE ACTION TASK ANALYSIS

For the purposes of this Paper it is assumed that a Mine Action Task is to be planned, it could be a survey or a clearance task. Also for convenience, it is assumed that satellite data is available and its use is intended.

The Task Analysis conducted by the Deminer will go something like that summarised in the figure 1. Detail is listed in table 1 at the end of the Paper.

The products of the analysis are the indicators to use to acquire the relevant satellite imagery and its assessment. The indicators will show where and when combat and mine action operations have taken place. These are the historical benchmarks that will indicate the required area for satellite coverage and the dates when areas should have been mine free and also when the areas may have been the scenes of combat and when they may have been contaminated. Comparisons of the imagery can then be made to search for evidence of military activity and landmine contamination.

INFORMATION SOUGHT

With the geographical area and times when satellite data is required in hand, the Deminer must decide next what to look for in the imagery.

First, will be to look at the geography and the terrain to identify any military significant targets and areas.

There may be strategically significant towns and radio/television stations or road and rail links. Tactically, there may be ground features that afford good defensive positions and others that would limit the access routes of an advancing enemy.

Next, the Deminer then looks for signs of military activity.

The debris of war is obvious.

Vehicle tracks and footpaths, additional buildings, tents, the termination of agriculture, overgrown areas, the erection of power and/or telephone lines; all are indicators of activities that could be military.

There are specific military indicators such as minefields, slit trenches, gun positions and weapon craters. Increased activity around water sources are good indicators of increases in population. Dust is a good indicator as vehicles make dust clouds and the dust settles on vegetation giving it a distinctive colouring.

The construction of minefields have a characteristic signature that includes vehicles tracks to deliver and sow mines, furrows or moved turf where the mines are planted, fencing and markers. Fencing is a give away as shadows of the fence posts may be clearly visible. Old minefields will inevitably be overgrown with scrub and small trees. The abandoned carcasses of camels, donkeys and wild animals are sure signs of a minefield.

A summary of combat and mine warfare indicators is given in table 2.

To the author’s knowledge, satellite imagery is likely to indicate the presence of minefields. It is unlikely to indicate signs of individual mines or munitions.

The Deminer will compare images of the mine free period with those of the time when mines had been laid and/or when combat has taken place. Later images will help relate temporal degrading and weathering. They will also show any breaching operations or combat damage done to the obstacles. Thus comparisons between the benchmarks of the mine free imagery with those containing contamination will be of use to the Deminer.

INFORMATION AVAILABILITY & RELIABILITY

Information availability is determined by the interest and resources of the host nation, the combatants and subsequent Deminers. For example NATO forces will mark and record minefields in English. Israeli and UK and US trained Arab armies will do the same but in their own languages. Terrorists and African militia are not so diligent. There is also a problem to find out
where the records are kept for many national
governments do not know records exist and many do
not even know where they are kept.

I have sought satellite imagery for Kuwait in 1991 and
Mozambique in 1994. Much was available to the
military. It was available to me, at a price. I could have
spent all of the contract monies on such imagery and
maps. But with fixed price contracts, they were not
affordable. Today we are using excellent satellite
imagery in Libya and Iran for prospecting Oil
Companies have ample monies to purchase them. The
images are used to confirm the location of facilities, aid
navigation and plan routes. They are not always of the
detail required to identify minefields. Satellite imagery
is particularly important and useful in countries where
the mapping is out of date or non existent.

There is also the problem of acquisition. Information is
power and it can be a source of income. It is not
unknown for doors to be closed to the UN but open to
favoured customers. Accurate details of minefields and
booby traps have been known to have been passed from
nation to nation only to be hijacked by an enterprising
Colonel seeking to enhance his retirement pension.

The most common problems are language and
geographic references. An interpreter may be required.
Details of the used geographical reference grid is
essential for accurate locating and cross referencing.

Another risk is false information. Mine warfare is a
psychological exercise, one mine can close a road with
a single vehicle casualty. A combatant might employ
phony minefields or generate false records to confuse.
Reliability and accuracy are essential.

HOW IIM CAN HELP

IIM can help if it can produce suitable images of the
designated areas in the periods of the historical
benchmarks. The Deminer can use such images to
compare the information and deduce indications of
military activities and the construction of minefields.

The extent of military activity can also indicate the
areas where unexploded munitions may be present.
With such information to hand the Deminer can focus
his efforts on where the munitions exist and plan his
operation with a better degree of safety and efficiency.

Should advances in the capture, generation and issue of
satellite data make it possible to locate individual
munitions, then such detailed information, if reliable
and accurate, will help provide an even safer
environment for cost effective mine action operations.

Today the EU Project STREAM seeks satellite
information of Angola and South Lebanon to continue
its Field Trials. To date no such information has been
forthcoming to help me write this Paper. I hope this
conference will pave the way for the acquisition.
Financial demands and commercial measures appear to
prohibit the distribution of mined information outside
the satellite agencies. Affordable satellite information is
urgently required today. Why should charges be made
when our taxes have been used to capture the
information? However, some charge may be
appropriate for the search and copying work, that is to
fund the IIM process.

CONCLUSION

It appears that IIM can help the Deminer with the
location and boundaries of combat areas and
minefields. Thereby, improvements in safety and
performance can be achieved.

The threat from individual mines and unexploded
munitions pervade the battlefield. For the time being,
they appear to elude reliable and accurate remote
detection.

IIM can help produce true mine truth, thereby:

IMAGE INFORMATION MINING CAN HELP
TRACK AND AVERT DISASTER
MINE ACTION INFORMATION ACQUISITION
(When Satellite Imagery is Available)

THE TASK

GEOGRAPHIC

MINE ACTION

LOCAL

HISTORICAL BENCHMARKS

COMBAT FREE PERIODS

COMBAT PERIODS

SATELLITE IMAGERY

AREAS

DATES

COMBAT CLUES

MINEFIELD CLUES

CONTAMINATED AREAS

Customer

Internet

NDO, MACC

Military, Police, People

Assess, Deduce

Acquire

Study, Deduce

Plot

Figure 1: Mine Action Information Gathering Process
<table>
<thead>
<tr>
<th>Step</th>
<th>Source</th>
<th>Information</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Customer</td>
<td>Task/Contract Reports Surveys Maps Customer’s Resources</td>
<td>Task Area Task Information Resources</td>
</tr>
<tr>
<td>2</td>
<td>Geographical Information (Literature &amp; Internet)</td>
<td>Terrain People Buildings Communications Roads &amp; Tracks Weather Natural Features</td>
<td>Strategic Features Tactical Features Natural Obstacles Weather Effects Physical Access Local Population Natural Resources</td>
</tr>
<tr>
<td>3</td>
<td>Mine Action Information (NDO, MACC, IMSMA)</td>
<td>Incident Reports Military Situation Combat History Terrorist Situation Police Activities Hazards Contaminations Casualty Reports Assessments Clearances Humanitarian Contacts Mine Types Munition Types Safe Routes Hospitals Medical Centres</td>
<td>Hazardous Areas Neighbours Liaison Contacts National Standards and Guidelines Safe Access Resources Maps</td>
</tr>
<tr>
<td>4</td>
<td>Local Information - Police Military Town Office Village Office</td>
<td>Routes Guides Contacts Emergency Support Local Combat History Resources</td>
<td>Combat Periods Combat Locations Safe Routes</td>
</tr>
<tr>
<td>5</td>
<td>Local People</td>
<td>Routes Guides Local Combat History</td>
<td>Combat Periods Combat Locations Safe Routes</td>
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<tr>
<td>6</td>
<td>INFORMATION ASSESSMENT</td>
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<td>7</td>
<td>Deduction of Historical Benchmarks – Pre-combat Mine Free Period &amp; Mine Laying and UXO Periods</td>
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<td>8</td>
<td>ACQUIRE RELEVANT IMAGERY</td>
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<tr>
<td>9</td>
<td>Satellite Imagery</td>
<td>Combat Indicators Minefield Indicators</td>
<td>Contaminated Areas</td>
</tr>
</tbody>
</table>

**DELIVERABLE = INFORMATION FOR TASK PLANNING**

Table 1: Mine Action Information Gathering Process
## COMBAT & LANDMINE ACTIVITY INDICATORS

<table>
<thead>
<tr>
<th>Activity</th>
<th>Information</th>
<th>Indicator</th>
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</thead>
<tbody>
<tr>
<td><strong>COMBAT</strong></td>
<td>Geographical</td>
<td>Rivers</td>
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<td></td>
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<td>High Ground</td>
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<td></td>
<td></td>
<td>Dominant Ground Features</td>
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<td>Steep Slopes</td>
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<td>Forests</td>
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<td>Marshes</td>
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<td>Flooding</td>
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<td>Concealed Routes</td>
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<td>Cities, Towns</td>
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<td></td>
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<td>Roads</td>
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<td>Bridges</td>
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<td>Embankments</td>
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<td>Railways</td>
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<td>Radio and TV Stations</td>
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<td>Military</td>
<td>Debris of war</td>
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<td>Gun positions</td>
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<td>Slit trenches</td>
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<td>Craters</td>
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<td>Increased traffic</td>
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<tr>
<td><strong>MINE WARFARE</strong></td>
<td>Geographical</td>
<td>Restricted valleys</td>
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<td></td>
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<td>Natural barriers</td>
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<td>Road, river &amp; canal crossings</td>
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<td>Overgrown areas</td>
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<td>Ambush sites</td>
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<td>Military</td>
<td>Defended areas</td>
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<td>Newly used areas and tracks</td>
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<td>Road signs</td>
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<td>Dust</td>
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<td>New footpaths</td>
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<td>New power lines</td>
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<td>New telephone lines</td>
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<td>Deviations/bypasses on routes</td>
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<td>Fences</td>
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<td>Dead animals</td>
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<td>Furrows in topsoil</td>
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<td>Turf and spoil</td>
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**Table 2: Combat and Landmine Activity Indicators**