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A Fresh Approach to Road Clearance Operations

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A Fresh Approach to Road Clearance Operations

UXB International has employed a combined approach to clearance activities in the Temporary Security Zone (TSZ) between Eritrea and Ethiopia. The author discusses how his organization uses this unique method of mine clearance.

by Roger R. Hess, *Africa Regional Director, UXB International*

Introduction

Many groups have inquired about the large number of hectares being searched and cleared by our small team assigned to the Route Verification and Clearance Program in Eritrea. While the approach we are using is unique, it is not completely original. Various clearance organizations have employed combined methods, and many have produced good results; ours simply takes the combined approach a couple steps further.

The objectives set out for our team were straightforward: search and verify the roadways in the TSZ; clear any signals encountered along the way; and do it in a manner that complements the capabilities of the Mine Action Coordination Center (MACC). The expected search rate of the Route Verification Team (RVT) was to be 15–20 km per working day while being able to detect a Russian TM-57 AT mine at 70 cm and a 100-mm piece of UXO at 100 cm.

UXB had already developed some rapid wide-area search techniques for site characterization projects on formerly utilized defense sites (FUDS) in the United States; however, we needed to adapt the equipment and the methodology to meet the challenges of the TSZ.

Infrastructure

The difference between Asmara and the TSZ is night and day, in both infrastructure and ambient temperature. Asmara is the capital city of Eritrea. It sits at 3,000 m above sea level, has modern facilities and good infrastructure, and was relatively untouched by the war. The TSZ is a 25-km wide stretch of land designated to separate the warring parties. To say this area is lacking development would be a severe understatement: the primary activity in this region for the last 30 years has been war.

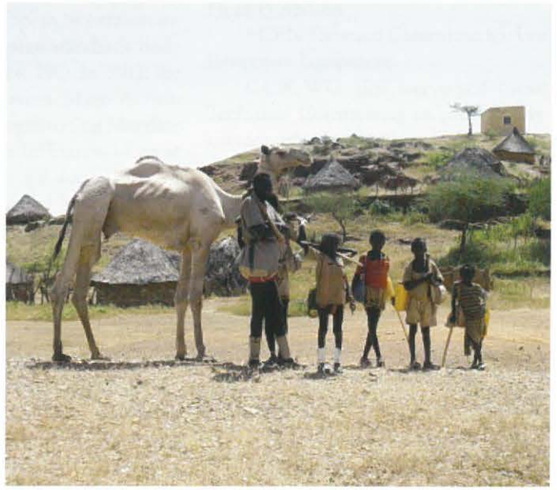
The drive into the western sector from Asmara is less than 200 km, but it takes six to eight hours, depending on traffic and weather. En route to the western sector, you pass through the cities of Keren and Berantu. One can find the basic food supplies to help sustain a field operation here, but potable water and any major equipment repairs or spare parts are simply not available and need to be brought in.

Upon leaving Berantu, you enter one of the poorest regions of the world. Small huts constructed from rocks, mud and straw make up the most of the structures. In spite of the hardships the local population endures on a daily basis, they remain extremely friendly and sociable.

Roadways

The TSZ has various mountain ranges weaving through it, and being a desert environment, washouts are extremely common during the rainy season. Berantu is the last city that has anything resembling pavement. The roads from here on out vary from extremely steep, four-meter mountain passes to fairly flat, nine-meter-wide main supply routes (MSRs). In the last 18 months, there have been more than 25 accidents involving AT mines on these roads, claiming the lives of locals and UN personnel.

(Below) A view of the TSZ. (Right) A local tribesman with his children outside Shambiko Village.



(Left to right) The main road leading from Berantu to Bushuka. Three UPEX detector coils mounted on PVC pipe to one of the earlier trailer systems. (Below) The computer workstation and control boxes for the UPEX detectors mounted inside the Samil 20 Mine Resistant Vehicle.

Prime Movers

The vehicle used as the prime mover for this project needed to be very robust, highly mobile and mine-resistant. Eritrea has a severe shortage of spare parts and trained maintenance technicians for modern vehicles, so the less complicated the vehicle is, the better suited it becomes.

For this, we selected the South African "Samil" series of vehicles. They were widely used in southern Africa and are still readily available to meet the ongoing demand. Like other systems built in South Africa, the vehicle was designed to work in harsh environments. A Deutz air-cooled, normally aspirated diesel engine powers the vehicle, and while it is very "agricultural" to drive, it is extremely mobile in off-road conditions, very reliable, and well-suited for this environment.

Detection System

UXB designed the Kinematic Induction Magnetic Survey (KIMS) system as a modular detection platform for the site characterization projects in the United States. To meet our scope of works, we decided to use the UPEX 740 wide-loop deep-buried landmine and UXO detection system made by Ebinger.

The antenna portion of the UPEX is made from a flexible coil similar to coaxial cables. This allows the operator to change the loop configurations between 1x1-m or 1x2-m loops, depending on the detection requirements.

Each configuration has its own unique characteristics and detection depths. The cables themselves are extremely lightweight, which allowed us to use the locally available materials such as standard PVC pipe to fabricate the carrier system. We've had excellent success with the UPEX in a "Mag & Flag" role searching for deeply buried landmines and UXO in southeast Asia over the past four years, and we were very confident that it would meet or exceed the requirements.

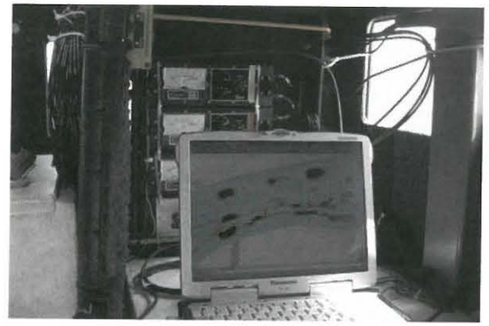
Differential Global Positioning Systems (DGPSs)

A DGPS is incorporated into the KIMS to accurately track, record and relocate the suspect signals. The KIMS was initially designed to search wide areas such as open fields, so static RTK transmitters with a "roving" receiver mounted on the detection platform were previously employed. This provides reacquisition capabilities of less than 20 cm; however, the drawback is the limited range. Depending on the terrain, the Rover can only travel four to six km from the static transmitter. Beyond that, the transmitter must be relocated and recalibrated.

To improve our range and productivity, we incorporated a wide-area DGPS system from Omni-Star, which is commonly used in large-scale agricultural and maritime applications. This does not require a static base station, and while the accuracy is only rated at +/- 100 cm, the system is reliably tracked anywhere in Africa.

Computers, Software and Peripherals

To keep everything as commercial off-the-shelf (COTS) as possible, normal Panasonic "ToughBook" laptops were used and standard PCMICA port expanders were installed. The detectors are timed and fired from a central control box, which also collects the signals. A custom-made "black box" combines the signals with the DGPS location and feeds this directly into the computer through the PCMICA slots. The commercially available Geosoft "Geosurveyor" program was then slightly modified to work with the new system.



The advantage of this approach is that the data is recorded and stored over 20 times faster than what can be accomplished with standard data-logging devices. The hardware involved with this configuration is small enough to be packed into a footlocker for transport and requires very little space when installed in the prime mover.

The X/Y locations of the route traveled and of the suspect signals located during the search are directly transferable into an MS Access database program. This allows all of the data recorded during the search to be used in standard Geographic Information System (GIS) software programs, such as ArcView or the Information Management System for Mine Action (IMSMA) database.

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Mounting Systems

The design of the system allows for a great deal of flexibility in how it is mounted, which proved to be one of its largest benefits.

Prior to our arrival in country, we planned to use a flexible sled design to tow the detection array. However, upon conducting operational assessments of the area, it was decided that the material of the roadways would destroy the sleds as fast as we could assemble them. We then decided to go with the traditional fiberglass trailer employed on the previous KIMS.

Once the trailer components arrived, we found that the undeveloped roadways in Eritrea were too much for the materials used. The flex of the fiberglass beams caused a severe amount of bouncing, limited the search speed to two to three km per hour and began to show stress cracks even prior to our deployment.

To correct these problems and increase our search speed, a suspended, front-mounted carrier was fabricated using the fiberglass beams from trailer and other locally available materials. This design provided a six-meter wide search path and included "wings" on either side that could be raised and lowered from the inside of the vehicle to allow for traffic and tight spots. Heavy-duty hinges were mounted to the front of the vehicle and bogie-wheels were placed on the carrier frame, allowing it to flex upward when making contact with the road while crossing riverbeds and washouts.

In spite of its crude appearance, the performance of this carrier was by far the best. The speed was increased to eight to nine km per hour, and the wider search path of the carrier allowed the KIMS system to scan over 35 km/210,000 sq m per day. This was a major accomplishment for the team, but it was only half the job. The next task is to clear the suspected signals located by the KIMS.

(Left to Right) A rear view of the front-mounted KIMS attached to the Samil 20. The side "wings" can be quickly folded up to work around trees and bushes.
Figure 1: Sample Map.

Mapping

Once the data is processed and analyzed, maps like the one in Figure 1 are printed for the clearance team. The blue path displays the total search swath, while the black lines show the individual search coils (three coils were used during the scan shown below). The red areas show the estimated boundaries of the suspect items and the yellow dots indicate the estimated center (or centers) of mass.

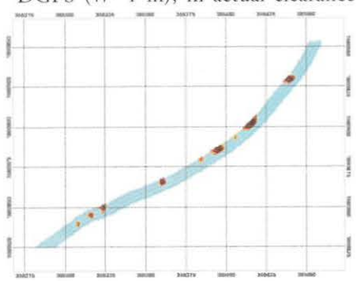
Combined Clearance Approach

Upon receiving the maps, the clearance teams begin planning their tasks. Areas that show very few signals obviously go very quickly, but most of the roadways produce a large number of signals, so the work becomes more intensive.

As the teams are working on roadways, the AP mine/tripwire threat is non-existent and freedom of movement is quite good. This allows for a great deal of flexibility in adjusting the approach.

Reacquisition

To accurately relocate the suspect targets, the location of each signal is transferred from the computer into a handheld DGPS/GIS unit with a backpack-mounted antenna. The reacquisition person then guides the team within two m of the suspect item and indicates where the point should be. Even though the accuracy of the backpack is rated the same as the vehicle DGPS (+/- 1 m), in actual clearance operations, the reacquisition person has commonly achieved +/- 30 cm while relocating the signal.



Once in the area, the deminer sweeps with the detector, looking for any signals. Surface scrap normally accounts for 80 percent of the items located, so once that is safely removed, the area is re-scanned for subsurface signals. Should one be present, the area is immediately marked for a mine detection dog (MDD) search.

Mine Detection Dogs

The MDD handler checks the area with both of the dogs. The area will be marked as hot from a single "positive" signal by either dog. However, if both dogs indicate no presence of explosive, then the signal is marked as "no explosive hazard" and the team moves on.

This has reliably eliminated an additional 80 percent of the subsurface signals remaining after the reacquisition team has moved on.

Mechanical Assistance

Trying to uncover a suspect signal buried deep in a sun-baked, dirt, clay and gravel roadway is simply asking for trouble. If done safely, only small gardening tools could be used, making it extremely tedious and time consuming. Picks are actually needed to break through the road surface, but this is unnecessarily dangerous for the deminer. So to counter this situation, mechanical assistance is brought in to help with the task.

The teams have a 5.5-ton armored mini-excavator, which performs 90 percent of all intrusive work and greatly improves the speed and safety. A mine-protected vehicle is also parked at the site, allowing the team leader to observe the task from close proximity should an accident occur.

Small signals comparable to those of a 60-mm mortar or a hand grenade are simply scooped up in the bucket and spread out for inspection by the manual team. Larger signals comparable to an AT mine are marked with a crossed circle. This tells the plant operator to dig on each side without touching the circle itself. This gives the manual team good access to the sides of the suspect item without applying any pressure to the top.

Quality Control (QC) Checks

An additional benefit of this approach is the ability to conduct verifiable QC checks using "seeds." These ensure the system is operating correctly and the depth of detection is being met.

A "seed" is an identical copy of what is being searched for (i.e., TM-57 AT Mine, 82-mm Mortar, etc). They are free from explosive (FFE) to ensure safety but are otherwise identical to the threat munitions of the area.

The Team Leader or Quality Assurance (QA) Inspector buries the seeds in randomly selected areas that have been scanned and directs the KIMS to rescan the site.

This can be used to compare against the other signals that have been located, or can be used in areas that show no contamination to verify that nothing is actually present. The system is fairly fool-proof: it either shows up constituting a "pass," or doesn't show up, which means it has failed and the area must be re-searched. To date, no seed has ever been missed.

Management Assistance

As mentioned before, the tracking and mapping system used on the KIMS can be directly transferred into a GIS. This can also be overlaid onto geo-referenced satellite images or aerial photography to give accurate information over topographical details that are only two to three months old. This provides the mine action manager an effective tool that can accurately track the progress and clearly show what is now considered safe.

Performance Data

Manufacturers often claim their systems "can, might or could" accomplish "X" number of sq m over a set period of time if the right conditions apply. However, the bottom line of "What has it done?" is not often answered with 100 percent accuracy.

The combined approach we are using in Eritrea has produced the following results in less than four months of operations:

- The KIMS scanned over 388 km/2,700,000 sq m of roadway. This was done in 19 days of scanning with a single vehicle and a four-man crew. Daily progress varies between 15 and 35 km per day, depending on traffic and satellite reception. The remaining time was spent processing the data to produce maps for the clearance team.
- During this period, the single Manual Clearance Team using the combined approach cleared over 112 km/785,000 sq m of the roadway scanned by the KIMS. This single team is comprised of only five personnel.
- Within the 112 km area, 2,167 suspect signals were recorded during the scan. The combined approach eliminated 2,090 of those signals without intrusive actions (i.e., digging).
- The remaining 77 intrusive actions produced one Russian-made PMD-6 AP mine, a Czech model 34 hand grenade, and various bomb fragments with explosive residue at depths ranging between 10 cm and 75 cm.

In comparison,

- A well-known clearance organization operating in the same area recently published that they had cleared 2,000,000 sq m in the last 24 months. This was accomplished through conventional methods and with a staff of over 350 people.

Gareth Hawkins of DDG/Karenswood checking a subsurface signal with MDD "Tom." If the MDD does not pick up an explosive scent, the area is double-checked with a second dog to ensure it is clear.

- Another clearance organization working in a nearby country with a much smaller team used conventional manual/MDD methods to clear 11 km of roadway. This project took 12 months.

The numbers speak for themselves.

While the system is still in its infancy for mine action, this combined approach of geophysical searching, topographical mapping, and following with manual, MDD and mechanical assistance has already proven to be fast, accurate and very cost-effective. As with any system, improvements can be made, and given the results produced so far, those improvements should not be too far on the horizon. ■

**All graphics courtesy of the author.*

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