EXECUTIVE SUMMARY

Live Site Classification Demonstration

ESTCP Project MR-201423

SEPTEMBER 2018

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1.0 INTRODUCTION

In June 2013, Tetra Tech was awarded contract W912HQ-14-C-0023 for Environmental Security Technology Certification Program (ESTCP) project Number MR-201423 to perform two Live Site Classification Demonstrations using advanced electromagnetic induction (EMI) sensors to perform Advanced Geophysical Classification (AGC). This is one of a series of Environmental Security Technology Certification Program (ESTCP) demonstrations of classification technologies for Munitions Response (MR). These demonstrations are designed to evaluate classification methodology at live munitions response sites. Tetra Tech performed Live Site Demonstrations at the Former Southwestern Proving Ground (SWPG), AR and the Former Joliet Army Ammunition Plant (JOAAP), AR.
2.0 OBJECTIVES

The primary objectives for the demonstration at SWPG were:

- Provide an opportunity for experience to new demonstrators and receive an official (Receiver Operating Characteristic) ROC curve.
- Assess classification performance where dynamic and cued data are used for the classification process, and where 20 mm projectiles are included in the targets of interest.
- Perform both the dynamic detection and cued interrogation surveys using only advanced sensors.
- Work with Black Tusk Geophysics (BTG) to compare classification results from UXOLab and UX-Analyze to determine strengths and weaknesses of both processes.

The primary objectives for the demonstration at JOAPP were:

- Test advanced classification technology at a site where Open Burn/ Open Detonation (OB/OD) activities were the primary source for UXO; OB/OD activities can lead to kick outs of whole or partial munition items.
- Perform both the dynamic detection survey and cued interrogation surveys using only advanced sensors.
- Assess the usability of a Robotic Total Station (RTS) and prism for spatially positioning advanced classification dynamic survey and cued data collection.
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3.0 TECHNOLOGY DESCRIPTION

Advanced electromagnetic induction (EMI) sensors used for these demonstrations included the following:

- Geometrics MetalMapper (MM) - SWPG
- Naval Research Laboratory (NRL) TEMTADS - SWPG and JOAAP

Geodetic systems used for these demonstrations included:

- Leica real-time kinematic global positioning systems (RTK GPS) - SWPG
- Trimble RTK GPS - SWPG
- Leica robotic total station (RTS) – JOAAP

Data processing software used for these demonstrations included:

- TEM to .CSV conversion software
- Black Tusk Geophysics (BTG), UXOLab - SWPG
- Geosoft Oasis Montaj, UX-Analyze extension – SWPG and JOAAP

The two Advanced Electromagnetic Induction (EMI) sensors, the Geometrics MetalMapper and the Naval Research Laboratory TEMTADS, are both designed to enable classification of TOIs using 3-dimensional transmitter and/or receiver coils. These systems have been proven at multiple ESTCP live-site demonstrations to be effective at discriminating between unexploded ordnance (UXO) and non-UXO items. Tetra Tech operated the MetalMapper in the dynamic detection mode and the TEMTADS in both Dynamic and cued modes. Tetra Tech utilized Geosoft Oasis Montaj UX-Analyze software for all data processing. Black Tusk Geophysics utilized UXOLab to process and select targets from the dynamic data collected at SWPG.
4.0 PERFORMANCE ASSESSMENT

At SWPG (Figure 1), approximately 1 acre of dynamic data were collected, and 2491 targets were selected for cued interrogation. No TOI were missed on the final classified and ranked list and approximately 87% of the clutter was rejected.

At JOAAP (Figure 2), approximately 2 acres of dynamic data were collected, and 1005 targets were selected for cued interrogation. Two classified and ranked lists were generated. The first missed no TOI but had a clutter rejection rate of only 22%. The second, missed several TOI, with a clutter rejection rate of 65%. Native Fuzes were very difficult to classify due to the presence of similarly sized and shaped clutter items. The ROC Curves for each demonstration are provided below.

Figure 1. ROC Curve for SWPG

Figure 2. ROC Curves for JOAAP
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5.0 COST ASSESSMENT

Primary cost drivers for AGC are as follows:

- Terrain/vegetation: challenging terrain/vegetation reduces production rate for dynamic and cued data collection and increases number of cued measurements that must be recollected.
- Anomaly Density: Higher densities increase cued data production in the field, but decrease the production of processing dynamic data.
- Size of the site: the larger the site, the more cost effective AGC will be.
- TOI: Small/difficult TOI decrease processing production rates and reduce the clutter rejection rate.
- Equipment reliability: stopping for repairs impacts cost and schedule.
- Sensor Availability: Costs vary significantly depending on the source of the AGC sensor: GFE, contractor-owned, commercially rented.
- QC Issues: The more QC issues, the higher the cost.

The cost benefit of AGC is directly related to the cost drivers listed above. In general, AGC is most cost effective when the TOI are very distinct relative to the expected clutter and the anomaly density is greater than approximately 400/acre. In this situation a 30-50% savings per anomaly can be achieved if AGC is utilized (with an ~80% clutter rejection rate) rather than intrusively investigating all targets. Sites with more difficult TOI will likely have lower clutter rejection rates and may have more QC issues. These factors may drive the cost of AGC to be more than intrusively investigating all targets, but the value of the higher quality data may motivate the use AGC regardless of the cost differential.
6.0 IMPLEMENTATION ISSUES

Due to the time that has lapsed since the field work and the preparation of the report, several factors related to implementing AGC technology have changed. The primary changes are as follows:

- The International Organization for Standardization 17025 Department of Defense Advanced Geophysical Classification Program (DAGCAP) Accreditation is now required to perform AGC for the DoD.
  - The accreditation requires companies to have a thorough Quality Management System in place and requires all personnel who perform AGC to have completed an internal or external Demonstration of Capability (DOC) before performing work.
  - There are currently two companies that manage the DAGCAP Accreditation and provide annual audits of the accredited companies.
  - There are currently 11 companies accredited to perform this work.

- TEMTADS is no longer available as government furnished equipment (GFE).

- The original MetalMappers have mostly been replaced with updated electronics equivalent to those of the new commercially available system, the MetalMapper2x2. This is also manufactured by Geometrics and the design is based on the TEMTADS. These may or may not be available as GFE.

- The MetalMapper2x2 can be purchased for approximately $130K and can be rented for approximately $750 per day. These prices make renting equipment cost prohibitive for long-term projects.

- The latest model of the MetalMapper2x2 still has hardware and software issues that are being working on by Geometrics. It is also currently missing the real-time field inversion capabilities, which will impact the number of targets that need to be recollected after the data have been processed.