MMRP Technology Update

Katherine Kaye
SERDP/ESTCP Support Office, HydroGeoLogic, Inc.
DoD’s Environmental Technology Programs

Science and Technology

Demonstration/ Validation
Program Area Management Structure

Weapons Systems & Platforms

Environmental Restoration

Energy & Water

Resource Conservation & Climate Change

Munitions Response
Today’s Topics

● Munitions Underwater

● Classification Applied to Munitions Response
Three Areas of Focus Underwater

- **Wide Area Assessment**
  - locate areas of concentrated munitions
  - requires high coverage rates and reasonable probability of detection

- **Detailed surveys**
  - locate individual munitions for removal or monitoring
  - requires high probability of detection and good geolocation

- **Enabling technologies**
  - geolocation technologies
  - mobility models
  - remediation technologies
Wide Area Assessment
Geophysical Sensor on Statistical Transects

Proposed Concept of Magnetometer Payload

Geometrics 823
Electronics Payload Magnetometer

Weston
TetraTech Hybrid System

- Vessel mounted LiDAR (80° swath angle)
  - Digital cameras (5 frames per/sec)
- RTK GPS, inertial positioning, and full motion compensation
- Multibeam echosounder, single or dual
- Dual or rotated single sonar scans river bank/shoreline/structure (120°-180° swath angle)
- Individual beams make up swaths (up to > 500 beams)
- Seismic reflection system produces profile view of sediment layers and thicknesses below seabed/bottom
- Sediment layers
- Sidescan sonar produces plan view image of seabed/bottom
- Gradiometer/magnetometer array (MGA) mapping ferrous anomalies

Unexploded ordnance magnetic field
Marine Towed Array

- Demonstrated and Validated System
  - Duck Naval Bombing Range, NC
  - Former Naval Ammunition Depot, Puget Sound
  - Lake Erie
  - Puerto Rico
  - Blossom Point

- 8 Total Field Magnetometers
Classification Applied to Munitions Response
Defense Science Board
UXO Clean-up Cost Break Out

- Site Assessment
- Survey and Mapping
- Vegetation Removal
- Scrap Metal Removal
- UXO Removal & Disposal

Indirect Cost
Direct Cost
Why Discriminate?

- Excavation of suspected UXO drives cost and time
- Less than 4% of excavations are UXO
  - Usually <1%
  - Ex. Camp Butner
    - 7 items out of > 100,000 digs
- Most items are harmless scrap
- Technology can now discriminate UXO from scrap
  - Result of a decade of R&D
  - Proof of concept demonstrated at three real live sites (FUDS)
Evolution to Live Site Demonstrations

- More meaningful results when we validate capabilities of currently available and emerging technologies on real sites
- Supports dialog with regulators and program managers
- Keep standardized test sites as intermediate step between system shakedown tests and live site demonstrations
New EM Technology

- New **UXO-specific EM technologies** have been developed and tested under SERDP & ESTCP

- All digital electronics, measuring complete eddy current decay cycle

- Collect more complete data on the target.
Demonstrations to Date

- **Completed**
  - Former Camp Sibert, AL – simple site, single munitions type
  - Former Camp San Luis Obispo, CA – more difficult, mix of munitions
  - Former Camp Butner, NC – small munitions (37 mm)

- **Ongoing**
  - Mare Island Naval Shipyard, CA – industrial site
  - Pole Mountain, WY – case study in implementation
  - Former Camp Beale, CA – trees, restricted access
  - Site TBD

- **Planned – additional demonstrations in FY12**
Camp Butner

Area A- Artillery Impact Area
Survey Sensor Systems

- Survey Sensors
  - EM61 Cart
  - MetalMapper
Cued Sensor Systems

- Cued Sensors
  - MetalMapper
  - Naval Research Lab Cued EMI array (TEMTADs)
Cued Area with Grid R21 Detail

~4.5 acres
2300 targets
Standard Processing Stream

- The standard processing stream for detection and classification of munitions using geophysical data

1. Data Collection

2. Parameter Estimation (Target Attributes)

3. Classification

Parameters

Non-munitions

Munitions
## Dig List Example

<table>
<thead>
<tr>
<th>Rank</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Can’t extract reliable parameters</td>
</tr>
<tr>
<td>1</td>
<td>High confidence munition</td>
</tr>
<tr>
<td>2</td>
<td>High confidence munition</td>
</tr>
<tr>
<td>3</td>
<td>High confidence non-munition</td>
</tr>
<tr>
<td>...</td>
<td>Can’t make a decision</td>
</tr>
<tr>
<td>...</td>
<td>High confidence non-munition</td>
</tr>
<tr>
<td>...</td>
<td>High confidence non-munition</td>
</tr>
<tr>
<td>...</td>
<td>High confidence non-munition</td>
</tr>
</tbody>
</table>

**Threshold**
Performance Evaluation

Receiver Operating Characteristic (ROC) Curve

Desired Performance
- 100% TOI recovered
- 0 non-TOI removed

Coin Flip
- 100% TOI recovered
- 100% non-TOI removed

Classification
- 100% UXO recovered
- 58% non-UXO removed

high confidence non-UXO
Camp Bunter: EM61-MK2 Cart

Number of Clutter Items

Percent Munitions Correctly Identified

- demonstrator threshold
- 100% of munitions correctly identified
San Luis Obispo: EM61-MK2 Cart
TEM TADS Cued Data

Number of Clutter Items

Percent Munitions Correctly Identified

- Demonstrator threshold
- 100% of munitions correctly identified
Implementation Approaches

- Hazard-based dig decision
  - High confidence non-hazardous anomalies remain in the ground
  - Remaining anomalies are dug

- Hazard-based dig protocol
  - High confidence non-hazardous anomalies dug with one UXO tech supervising a team of lower-cost diggers
  - Remaining anomalies are dug with usual procedures (UXO personnel and safety equipment)

*Approach would be site dependent and determined by the site team*
Breakdown of Nominal $200M FUDS MMRP

2003 DSB UXO Report
Breakdown of Nominal $200M FUDS MMRP

75% Reduction in False Alarms
Breakdown of Nominal $200M FUDS MMRP

90% Reduction in False Alarms

Component Costs ($K)

Site Assessment  Survey & Mapping  Vegetation Removal  Scrap Removal  UXO Removal & Disposal  Acres Remediated

Thousands of Acres per Year

0  5  10  15  20
0  20  40  60  80  100  120  140  160  180  200

DDES April 2011
Web site
www.serdp-estcp.org

Symposium
November 29 – December 1, 2011
Washington, D.C.