15 January 2014

Geomine Demonstration Test 2012/2013

OBSERVER REPORT

1. Background

In 2013 the Geneva International Centre for Humanitarian Demining (GICHD) participated as the lead observer in the Geomine demonstration test in Wittstock, Germany.

The technology demonstrated focuses on reducing suspect hazardous areas (SHA) based on the spectral identification and characterisation of the vegetation of the SHA. According to UN estimates, approximately 80 per cent of all land designated a SHA is in fact free from landmines. Identifying areas that are free from mines is the underlying concept of the Geomine tool.

TNT (Trinitrotoluene) is the most commonly used explosive in military and industrial applications. It is used in landmines, bombs, shells, grenades and many other explosive devices. The technology relies on this fact. TNT consists of nitrogen, and when ERW are buried in the ground, they release small amounts of nitrogen which is then absorbed into the ground and metabolised by the surrounding vegetation. Under certain conditions, still to be fully investigated, this extra amount of nitrogen could produce changes in the vegetation spectral response. If these changes are detectable and can be directly and unequivocally attributed to TNT contamination, then high-resolution hyper spectral remote sensing could be considered a suitable technique for supporting SHA's reduction.

2. Methodology and approach

The demonstration was carried out in Wittstock, Germany. The area, located approximately 80 km northeast of Berlin was suggested by the German Federal Foreign Office (GFFO). It consists of 120 square km, and is considered highly contaminated as it used to be a military training ground area, initially established by the Soviet Army in 1952. During this time, the area was used for various operational training sessions, including air bomb droppings, tank fights and field simulations etc. Thus, a wide range of ammunition was deposited, resulting in a high average of possible pollution in most areas of the training ground. In the past years, different areas were cleared to various depths.

However, detailed information about investigated areas and about how items found were cleared or removed is not available. The military training ground was closed on 13 January, 2011. Currently the site is managed by the Bundesforst (as part of the Bundesanstalt für Immobilienaufgaben) which is responsible for clearing tracks and paths to enable forestry activities in the area. The vegetation on the site differs between areas with very little vegetation, moorland with dense vegetation and forest areas with uneven ground.

Figure 1: Examples of the vegetation in the area of Wittstock

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Following the aerial survey and delivery of the final mapping product by Geomine, a verification test was carried out in April and May 2013 by the commercial company Sensys, using the Sensys push-cart magnetometer system MAGNETO® MXPDA, which is a field survey system for the detection of ferromagnetic objects in small- and medium-sized areas. The detection system was selected based on the assumption that most explosives in the area have a metal casing. Due to limited funds, only two hectares of land were processed, corresponding to the locations marked as contaminated or uncontaminated by Geomine.

The GICHD and Sensys agreed on the following work:

a. to conduct a geo-referenced survey for a total area of 20,000 m²;
b. the division of the area into various box sizes measuring between 20 x 20 and 40 x 40 metres;
c. the completion of data analysis of the readings from the MXPDA 5 channel magnetometer system;
d. to generate a list including UXOs fired or placed in the training ground;
e. to excavate all suspicious objects for verification;
f. to identify and catalogue all suspicious objects; and
g. to hand any UXOs over to the local authorities overseeing the UXO clearance for the Wittstock area.

The selection of the specific survey boxes was based on various criteria:

a. areas of high interest;
b. areas with former known training activities including target areas;
c. areas categorised as highly polluted by the leading survey method;
d. areas categorised as lightly polluted by the leading survey method;
e. a mixture of easily accessible and hard-to-reach areas; and
f. *ad hoc* decisions during field inspection and the planning phase.

Due to the reduced size of the investigated area, this verification method was expected to provide only general indications about the accuracy of the Geomine product. Therefore, during the autumn of 2013, the GICHD conducted an additional screening of the results using the remotely sensed data provided by GeoMine.

Finally, the magnetic mapping of the area (of around two hectares) was split into 21 survey boxes.


Survey boxes 1 and 2


Survey boxes 3, 4 and 5

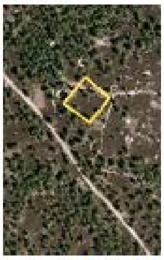

Survey boxes 6 and 7


Survey boxes 8 to 12


Survey boxes 13 and 14


Survey boxes 15 and 16


Survey box 17


Survey box 18


Survey box 19


Survey box 20


Survey box 21

The mapping of 21 different boxes with sizes approximately between 20 x 20 m and 40 x 40 m was done by SENSYS and took four days. A total area of 21,623.82 m² was surveyed.

A total of 5,713 magnetic signatures were listed, where 559 were categorised as relevant according to the project objectives. The check-up and excavation of those 559 objects was done by MAKS (a German commercial clearance operator) and took six days.

With 554 listed magnetic objects, survey box 18 contained the most entries, however only 12 were categorised as relevant. With 58 listed magnetic objects, survey box 2 contained the least of entries, of which only four were categorised as relevant. With 109 relevant magnetic objects of a total of 271 magnetic objects, survey box 13 contained most relevant entries. The survey boxes 5, 13, 14, 15, 17 and 19 each contained more than 40 relevant magnetic objects that needed checking and excavation.

a. Two kinds of areas were pointed out by Geomine – those which were found to be clear/uncontaminated according to Geomine tool (GROUP A), and those which were found to have a high probability of contamination – those areas were given a buffer of a 20 metre radius (GROUP B).
b. Out of the total area of 120 km², 89 per cent of the area was indicated by Geomine as GROUP A and 11 per cent as GROUP B.
c. The indications in each box were investigated by Sensys. Of the 21 boxes of various sizes that were chosen according to the criteria mentioned above, 12 were selected from GROUP A and 9 from GROUP B.

The results observations, conclusions, comments and recommendations are presented below.

3. Results

The investigation of the boxes in GROUP A found full accuracy between the Geomine findings and Sensys verification, i.e., locations that were indicated by Geomine as clear/uncontaminated were confirmed to be 100 per cent clear/uncontaminated. See the list of conformed, uncontaminated boxes below:

Box	Approx. size in m	Approx size in m²	Corner coordinates WGS-84 (North East)
4	20x20	400	53°10'27.0122" N; 12°42'37.6505" E, 53°10'26.4022" N; 12°42'38.0389" E, 53°10'26.1500" N; 12°42'37.0426" E, 53°10'26.8710" N; 12°42'36.6057" E
5	20x20	400	53°10'25.4369" N; 12°42'37.1505" E, 53°10'24.7567" N; 12°42'37.6177" E, 53°10'24.4167" N; 12°42'36.6946" E, 53°10'25.2550" N; 12°42'36.0933" E
6	30x30	900	53°10'00.1693" N; 12°40'58.3363" E, 53°10'01.1084" N; 12°40'58.7167" E, 53°10'00.7094" N; 12°41'00.4104" E, 53°09'59.8055" N; 12°40'59.8120" E
7	40x40	1,600	53°10'01.5109" N; 12°41'06.1036" E, 53°10'01.1302" N; 12°41'08.1277" E, 53°09'59.9162" N; 12°41'07.3600" E, 53°10'00.1913" N; 12°41'05.2860" E
8	30x30	900	53°06'46.2515" N; 12°40'30.3623" E, 53°06'47.2238" N; 12°40'30.4030" E, 53°06'47.2054" N; 12°40'32.0018" E, 53°06'46.2372" N; 12°40'32.1287" E
9	30x30	900	53°06'47.2270" N; 12°40'26.9564" E, 53°06'46.2617" N; 12°40'26.6290" E, 53°06'46.0615" N; 12°40'28.2216" E, 53°06'46.9632" N; 12°40'28.5002" E
12	20x20	400	53°06'43.1772" N; 12°40'08.5856" E, 53°06'42.3243" N; 12°40'08.4068" E, 53°06'42.4763" N; 12°40'07.4074" E, 53°06'43.1171" N; 12°40'07.5042" E
14	30x30	900	53°07'28.3027" N; 12°40'40.3803" E, 53°07'29.3058" N; 12°40'40.4976" E, 53°07'29.3694" N; 12°40'38.8868" E, 53°07'28.3950" N; 12°40'38.7660" E
15	40x40	1,600	53°04'48.2982" N; 12°40'00.5594" E, 53°04'47.3484" N; 12°39'59.1324" E, 53°04'46.5347" N; 12°40'00.7652" E, 53°04'47.6312" N; 12°40'01.9144" E
16	30x30	900	53°04'50.2376" N; 12°40'02.9978" E, 53°04'50.9415" N; 12°40'01.8699" E, 53°04'51.6158" N; 12°40'03.0032" E, 53°04'50.5615" N; 12°40'04.5177" E
17	40x40	1,600	53°04'31.3389" N; 12°39'19.3177" E, 53°04'32.6051" N; 12°39'18.9199" E, 53°04'32.6692" N; 12°39'21.0721" E, 53°04'31.5996" N; 12°39'21.4141" E
18	40x40	1,600	53°04'36.3482" N; 12°40'06.3482" E, 53°04'37.4776" N; 12°40'07.9230" E, 53°04'36.5772" N; 12°40'09.4621" E, 53°04'35.5371" N; 12°40'08.2085" E

Testing of GROUP B – Sensys found that the areas indicated by Geomine as potentially contaminated were fully or partially clear/uncontaminated:

Box	Approx. size in m	Approx size in m²	Corner coordinates WGS-84 (North East)
1	20x20	400	53°11'50.6761" N; 12°42'17.1877" E, 53°11'51.2999" N; 12°42'17.4655" E, 53°11'51.1465" N; 12°42'18.5147" E, 53°11'50.5252" N; 12°42'18.2392" E
2	20x20	400	53°11'52.1581" N; 12°42'20.1092" E, 53°11'52.8153" N; 12°42'20.3755" E, 53°11'52.7098" N; 12°42'21.4368" E, 53°11'52.0780" N; 12°42'21.1684" E
3	20x20	400	53°10'31.6933" N; 12°42'36.3422" E, 53°10'32.2636" N; 12°42'35.9334" E, 53°10'31.9962" N; 12°42'34.9508" E, 53°10'31.4380" N; 12°42'35.4342" E
10	30x30	900	53°06'44.2639" N; 12°40'15.7227" E, 53°06'43.3663" N; 12°40'15.0475" E, 53°06'43.1453" N; 12°40'16.6316" E, 53°06'43.9855" N; 12°40'17.2899" E
11	30x30	900	53°06'43.0490" N; 12°40'12.0597" E, 53°06'42.0833" N; 12°40'11.7087" E, 53°06'42.5058" N; 12°40'10.1294" E, 53°06'43.4398" N; 12°40'10.5862" E
13	30x30	900	53°07'27.5038" N; 12°40'47.3365" E, 53°07'26.7415" N; 12°40'46.3620" E, 53°07'27.1025" N; 12°40'44.8955" E, 53°07'27.8909" N; 12°40'45.8495" E
19	40x40	1,600	53°05'03.0168" N; 12°40'01.4879" E, 53°05'04.1386" N; 12°40'02.4325" E, 53°05'03.6362" N; 12°40'04.4637" E, 53°05'02.4808" N; 12°40'03.4410" E
20	40x40	1,600	53°05'15.0267" N; 12°41'06.3639" E, 53°05'16.1270" N; 12°41'05.4738" E, 53°05'16.7717" N; 12°41'07.4040" E, 53°05'15.5999" N; 12°41'08.3449" E
21	40x40	1,600	53°10'56.2380" N; 12°39'55.7849" E, 53°10'55.3802" N; 12°39'56.5731" E, 53°10'54.8357" N; 12°39'55.3283" E, 53°10'55.6170" N; 12°39'54.3582" E

As an example – survey box #13 (a total area of 900 m²) revealed 109 relevant objects that needed to be excavated. These objects were mostly anti-tank training mines with no explosive content as well as shrapnel and scrap metal.

Figure 49: Part of missile and anti tank mine, ammunition and small parts of metal

The figure below (figure 1.) represents the findings of both Sensys and Geomine. The black circles represent Geomine findings, including the 20 metre radius – this area in Polygon #13 was found to be contaminated. The white spots represent Sensys findings, and include parts of missiles, anti-tank training mines with no explosive content, splinters/fragments, metal sheets, pieces of 30 mm grenades, parts of missiles and more. No explosive items were found.

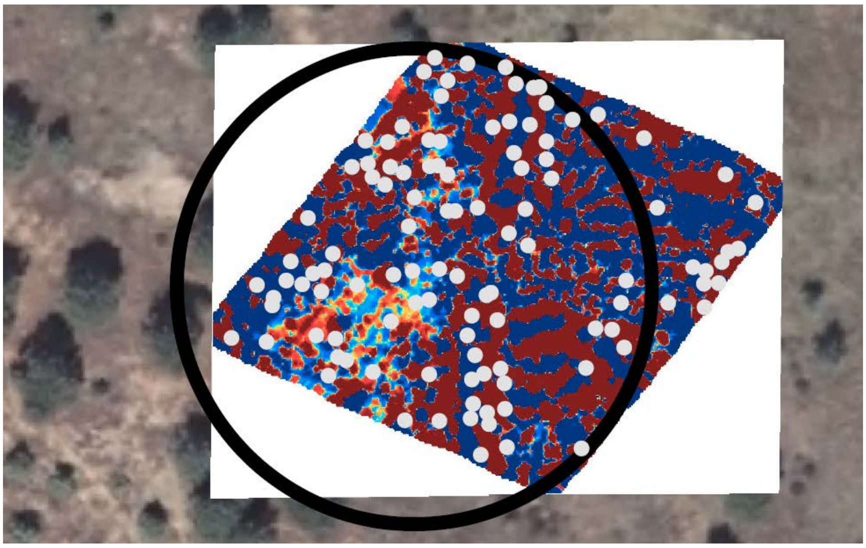


Figure 1.

3. Conclusions

a. The accuracy of both radiometric and spatial corrections of the images is good and adequate to the scope of this demonstration.
b. The presence of significant spectral differences between contaminated and non-contaminated areas should be proven.
c. Both statistical representativeness and reproducibility of results in operational scenarios should be verified.
d. According to the multi-scale image data analysis in the test plan, this study should also enable the accuracy of the detection to be defined, according to different spatial resolutions. The optimal spatial resolution for ERW detection should also be determined to optimise the flight parameters and reduce costs.
e. .

4. Comments and observations

a. The mine action community could benefit from a better understanding of the prerequisites and influencing factors of the tool in order to understand when and how to use it properly and manage user expectations.
b. The current pricing of the use of the technology needs to be reviewed and options for reducing the costs associated with its use should be considered.
c. It needs to be established how and where the technology fits into the current land release methodology (IMAS 7.11) and how the technology can be practically applied in support of the process.

d. The expected accuracy of the method in each environment should be defined and it would be very useful to classify all detections according to their reliability.
e. The effectiveness of this technology in areas with no vegetation should be clarified and proven through further tests and research.
f. The logistics and supply chains should be simplified.
g. The very high number of readings in the Geomine product makes the interpretation and evaluation of the results difficult.
h. It should be noted that the system is not adequate to the identification of exact UXO locations due to the current 20 metre radius (an area with a total size of 1,256 square metres). Larger sizes will require clearance to verify the presence or absence of explosive items. Considering the high spatial resolution of airborne imagery (3 metre), further explanations should be provided about how the current 20 metre radius accuracy has been calculated.

5. Questions

The GICHD also suggests further investigating the following technical aspects, in order to better define the operational applicability of the proposed technology:

1. How long do the objects need to be in the ground before having an effect on the vegetation?
2. What is the effect of different kinds of soil, terrain and vegetation (types of trees, grass etc.)?
3. What is the best season(s) for use of the technology, according to the phonological cycle of contaminated vegetation?
4. What is the effect of contamination on different vegetation and, consequently, the possibility of detection?
5. What is the effect of different kinds of explosives at different depths?
6. What are the effects of: contaminants like chemical fertilisers; environmental conditions; or successful detonations of ordnance?
7. What decisions are left to a human analysis after the model has provided an objective baseline? How much pre-knowledge of the conflict and SHA is required in order to interpret the results?