EXPLORING THE IMPORTANCE OF INTEGRATING GIS WITH SATELLITE REMOTE SENSING AND FIELD SPECTROSCOPY FOR MILITARY & SECURITY APPLICATIONS IN CYPRUS

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Overview

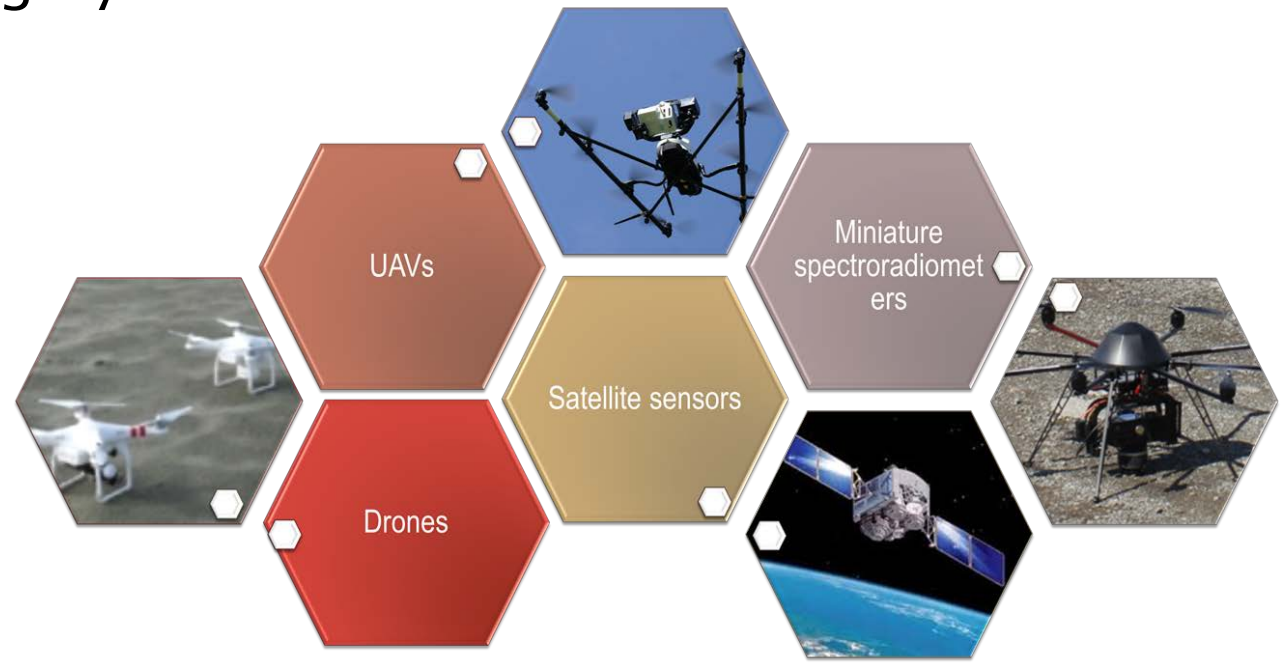
- Objectives
- Theoretical Background
- Methodology
- Preliminary Results
- Remarks
- Future Work

ABSTRACT

- Indeed, GIS is an increasingly important technology to the military. GIS can be applied to a wide range of military applications as shown from various researchers.
- However, there is a great need to integrate information from a variety of sources, sent at different times and of different qualities using GIS tools. GIS present considerable challenges for military developers. Many of the problems are unique to the military and demand innovative solutions.

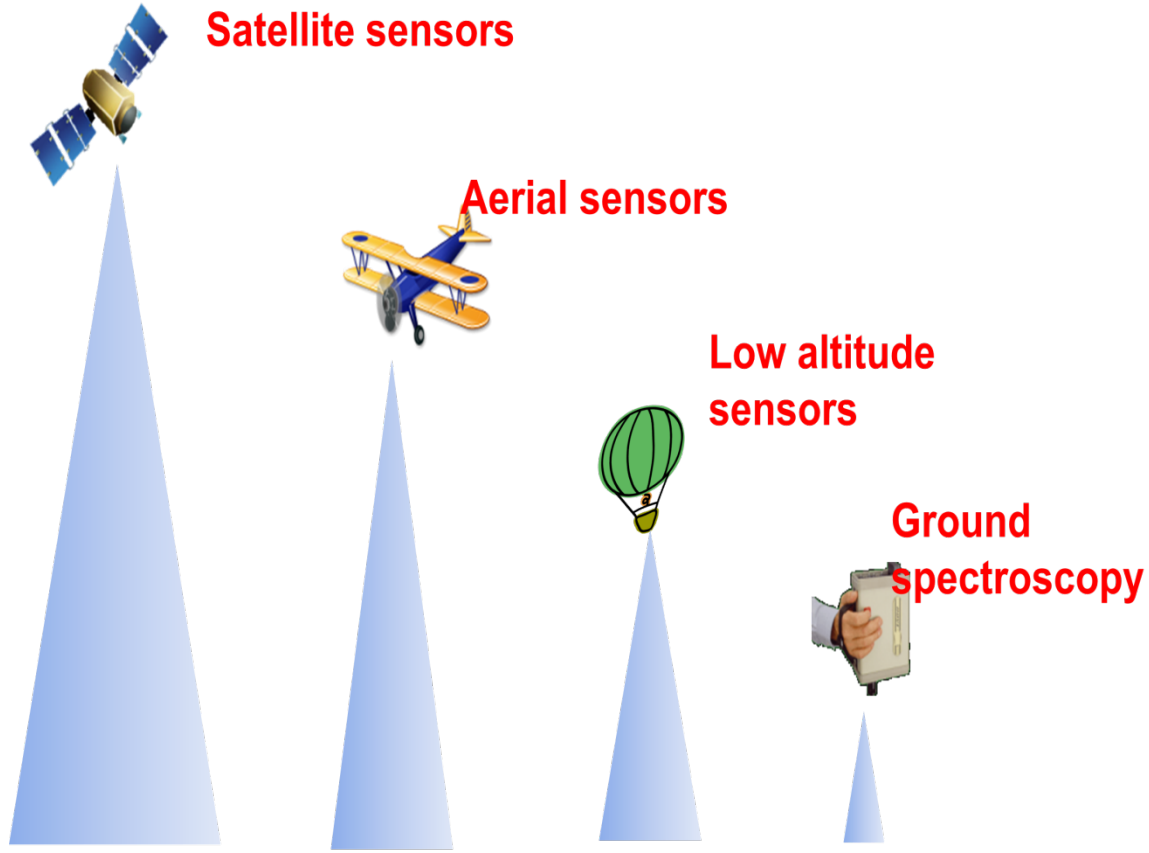
Objectives (1)

- To explore how GIS can be used to manage and support a national research project for detecting 'buried' military underground structures in the area of Cyprus using UAV, field spectroscopy and satellite imagery.



Objectives (2)

- To reach this goal several other auxiliary data have been used such as: ground truth data, meteorological data, remotely sensed data, modelling techniques



Objectives (3)

- To examine how underground structures can affect their surrounding landscapes in different ways such as vegetation vigour. Indeed, This latter indicator is often observed on the ground as a stress vegetation; a phenomenon which can be used to denote the presence of underground structures.
- To identify, define and analyze 'test' areas.
- To use the GIS as a supporting tool to analyse the acquired data from various sources and provide the most appropriate suggestions to the government.

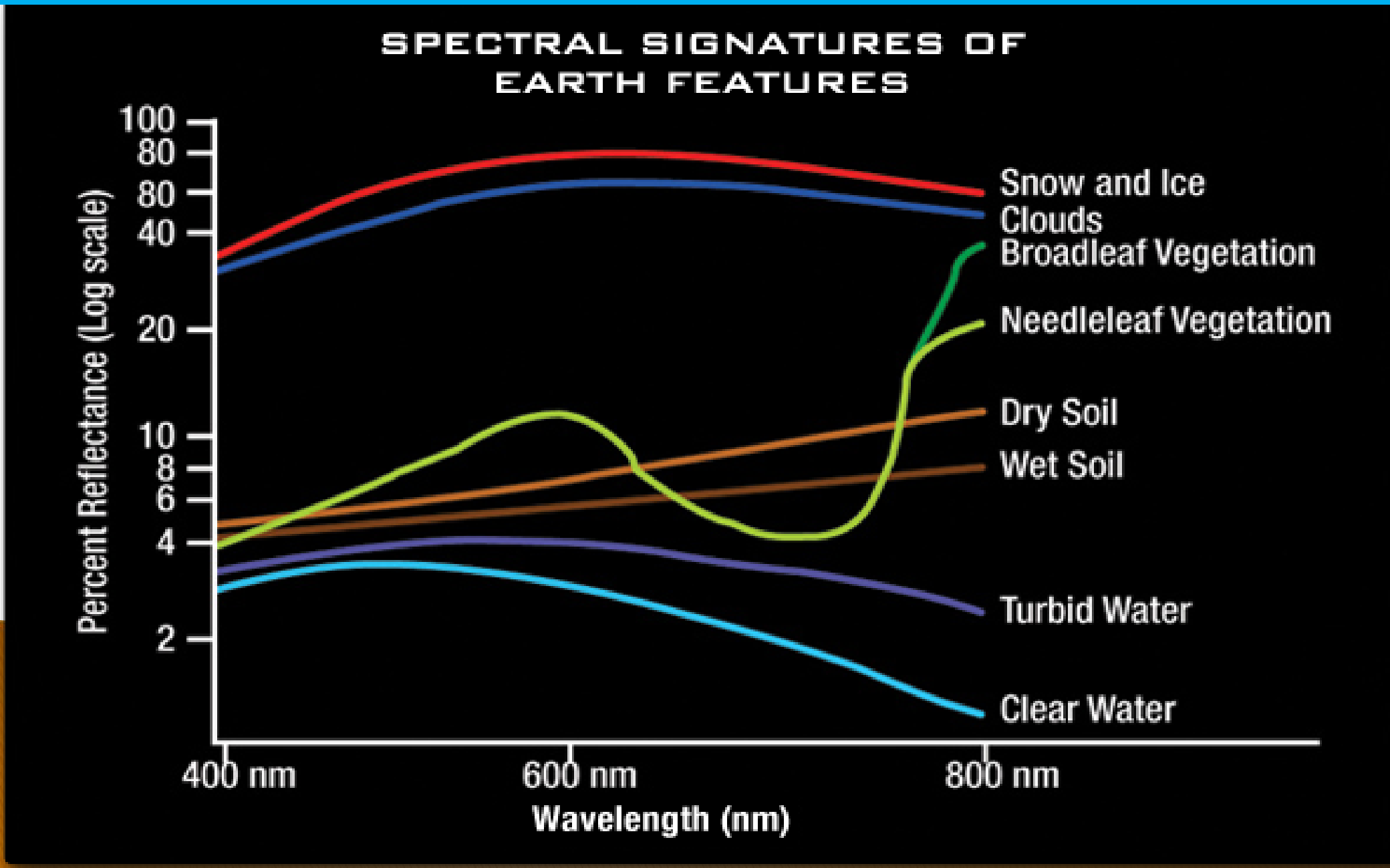
Theoretical background (1)

- As military buried' underground structures is difficult to detect them especially when are cover by ground.
- A reasonable solution to the problem may be found by combining traditional geological and geochemical techniques with remote sensing. For an initial evaluation interpretation of remote sensing data provides information about the location (Singhroy et al., 1996).

Theoretical Background: Field spectroscopy

- The most widely used methodology in field spectroscopy concerns measurements of the reflectance of composite surfaces in situ (Milton et al., 2009).
- Increasingly, spectral data are being incorporated into process-based models of the Earth's surface and atmosphere, and it is therefore necessary to acquire data from terrain surfaces, both to provide the data for modeling specific parameters and for assisting in scaling-up data from the leaf scale to that of the pixel (Papadavid, 2011).

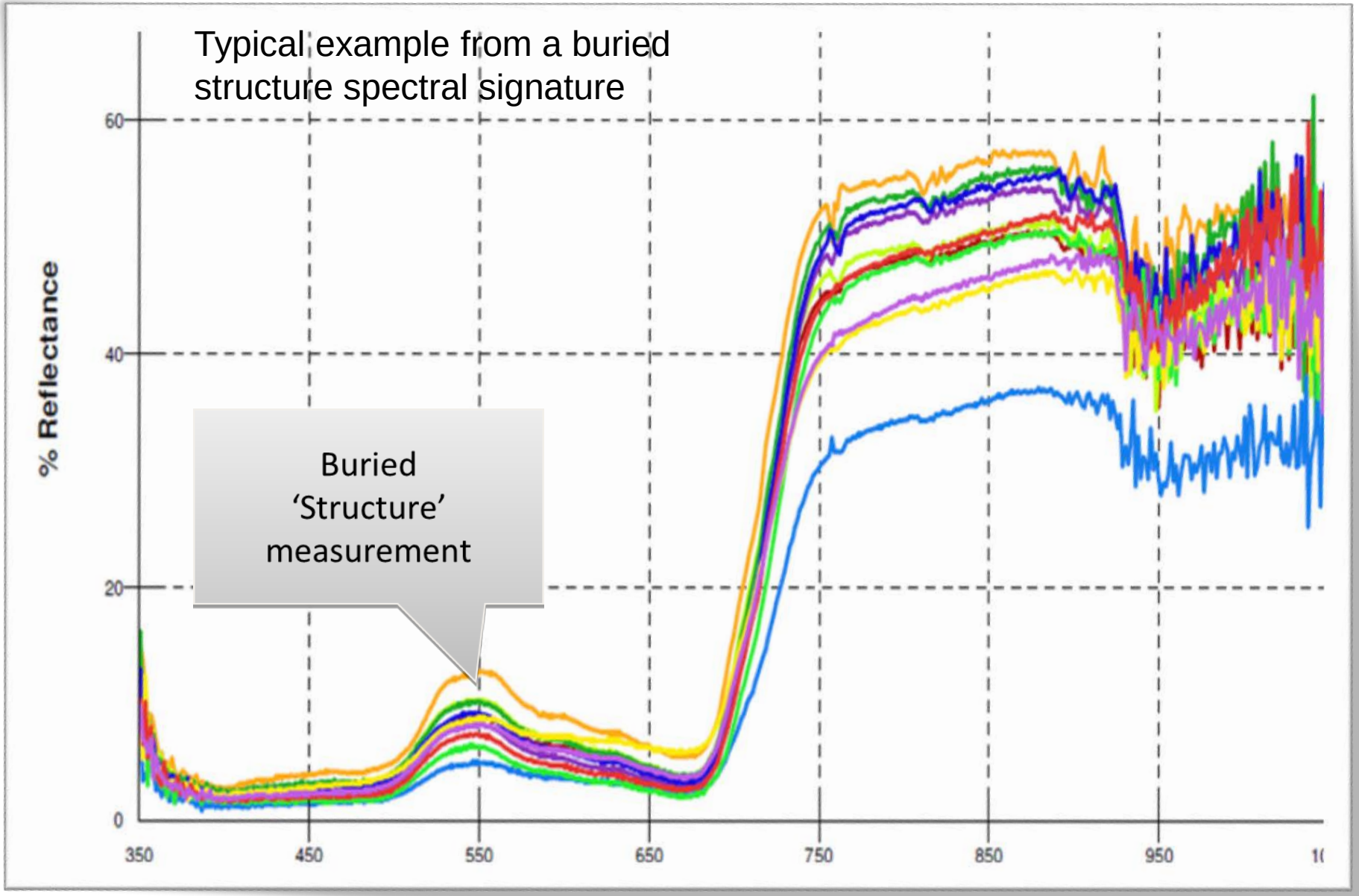
Spectral signatures of different Earth features within the visible light spectrum are shown below.(http://missionscience.nasa.gov/)



- The use of spectroradiometer can facilitate the procedure since it provides a spectrum which can be adapted to satellites' bands by simple transformation, using RSR filters of each satellite.
- The methodology followed can be applied for any place since it can be considered as 'algorithm adaptation' to local conditions. The models developed though can be used only in Cyprus, since they refer to its conditions.

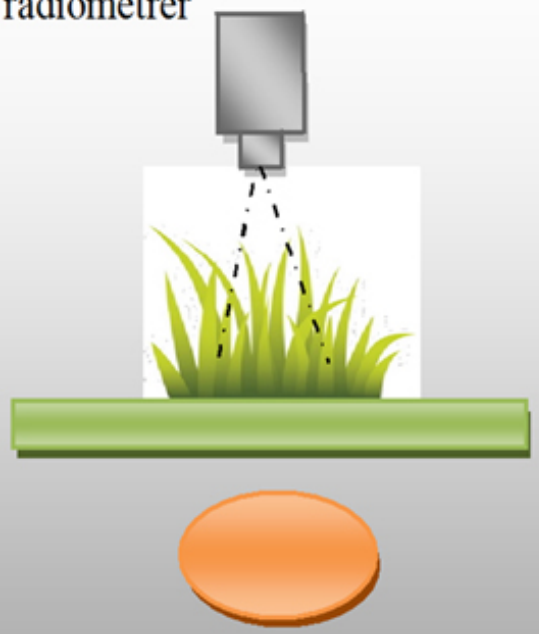
Theoretical background (2)

- On the basis of the interpretation of a satellite airborne and ground data, maps are compiled which show areas where are located 'buried' underground structures. This is done by documenting and assessing soil anomalies and by interpreting vegetation anomalies which may serve as indicators.
- Surveys can be made at different time to document the development of the area. Moreover sensors sensitive in different ranges of the electromagnetic spectrum allow the recognition of different types of ground cover. The whole range of digital processing procedures can be used to enhance the images. (Singhroy et al., 1996).



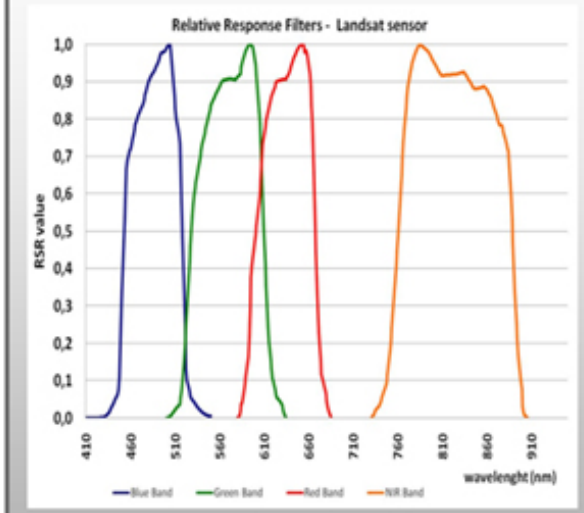
Wavelengths in nanometers

Spectro-radiometrer



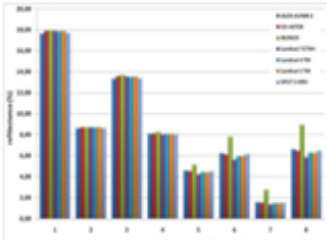
Step A
(Field measurements)

RSR filters



Step B
(Up scaling)

Comparison of spectral signatures and Vegetation Indices

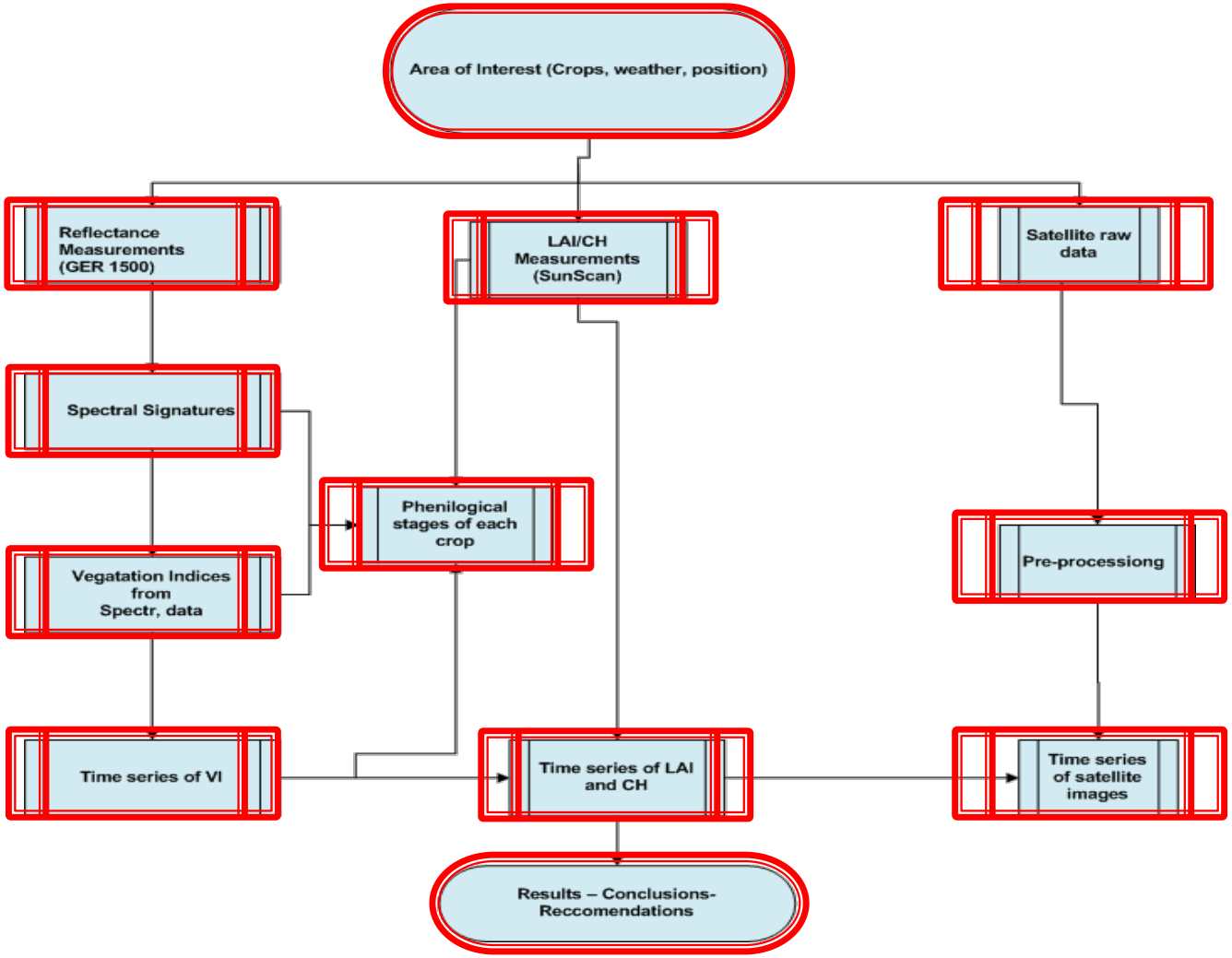


Step C
(Evaluations)

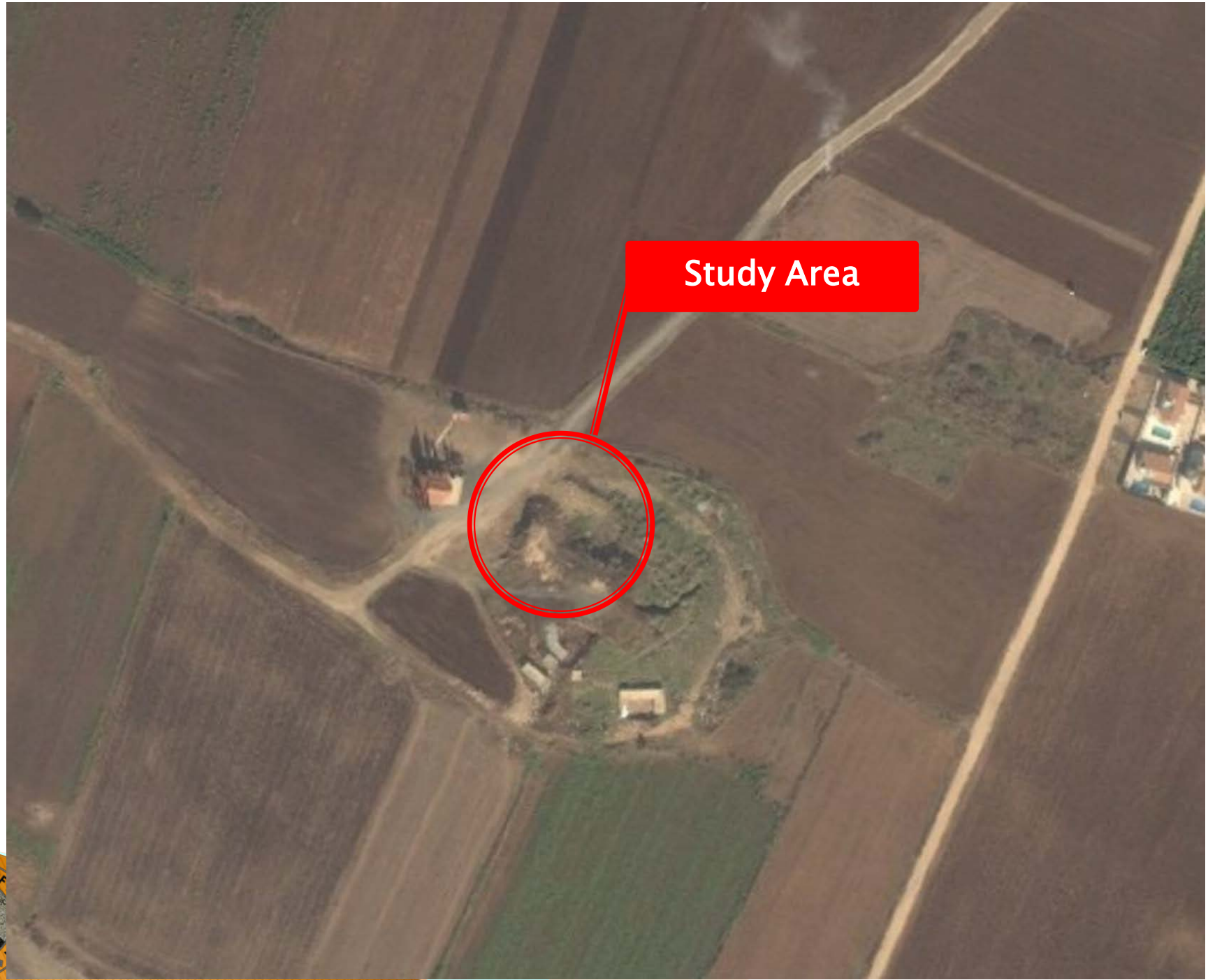
Methodology

- **Field Spectroscopy**: determine in-band reflectance's for several satellite sensors over different scenarios
- **Satellite Remote Sensing**: pre-processing (geometric, radiometric, atmospheric correction) to bring the data or image to a more accurate and usable condition, post-processing (classification)
- **UAV**: visible, IR, thermal images
- **Auxiliary data**: meteorological parameters, soil conditions, type of crop/target using LAI (Leaf Area Index) and CH (Crop Height) for monitoring crop growth

Methodology Flow Chart



Finally we have the results conclusions and recommendations

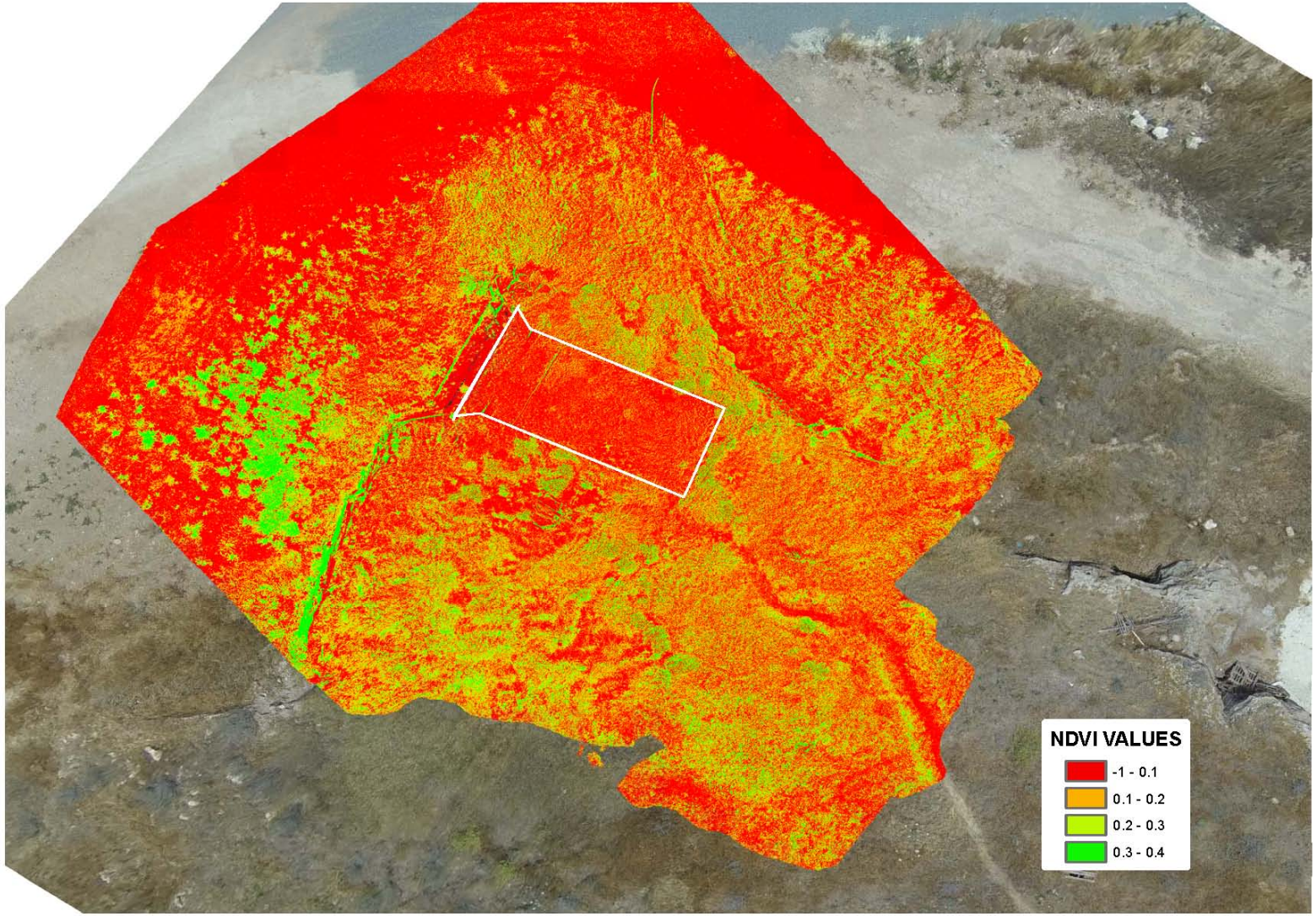

Study Area

Preliminary results

- Field Spectroscopy measurements
- UAV images

Image From UAV

NDVI (Normalized Difference Vegetation Index) Image From UAV



Remarks

- Field Spectroscopy is an ideal tool for determining the spectral signatures of military targets.
- In-band reflectance's from ground (SVC2014 spectroradiometer) can be used to assess the effectiveness of several available satellite sensors.

Future Work

- Further testing and field spectroradiometric measurements.
- Object-based classification.
- Develop the suitable 'smart' index for detecting military targets.
- GIS will be used as a monitoring and decision making tool from the government to run military and security issues (e.g. thematic maps of the existing military targets).

Thank you.

Are there any questions?