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Integrated Processing And Ground Truthing Of Hyperspectral And LiDAR Images in Archaeology

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Heritage landscapes are fragile and once lost, irreplaceable.
  • => Distribution (spatial relation/variation) and state of preservation of sites is important for policies on protection

RS potentially provides significant added value to identify/inventories archaeological sites

Current problem:
  • Due to characteristics of the large majority of archaeological sites
    • The spatial and spectral resolution of any RS data must be extremely high
    • Processes producing signatures are not well understood
      • Sensing campaigns cannot be well targeted or designed

To define the resolution requirements:
  • One must investigate the processes producing remotely detectable geo–archaeological signatures
Context of the project

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bridging factor

- traditional archaeology
- explicit
- implicit
- modelling + simulations
- Archaeological Remote Sensing

Spatial scale
Aim of the 2-year project

- Spectroscopy for studying archaeological features and deposits and the post-depositional processes affecting the archaeological record.

- Integration of hyperspectral and LiDAR data for the identification of ancient natural and cultural features

- All applied in two different environments:
  - The flat Great Hungarian Plain
  - High mountain relief in Calabria
Work packages ANAGHLIA project

**WP1: EXPERIMENTAL DESIGN**
Hyperspectral signatures of archaeological sites and “false positive” phenomena

**WP2: UPSCALING TO THE RS SCALE**
Hyperspectral and LiDAR data for integrated processing

**WP3**
Methodology validation and comparison of different environments

KU Leuven - JGU-MPI
Field data + target sites: HNM-NHC - GIA

VITO – KU Leuven

Field verification checks HNM-NHC - GIA
Phase 1:
- Analyse surface soil reflectance spectra using
  - Spectral feature analysis
  - Specific absorption feature parameters
- Record distribution of soils at scale 1:1000
  - Carry out lab analyses
- Relate surface spectra to the spectra recorded in vertical sections and to the soil characteristics and thus to the origins of the strata.

Phase 2: Comparing, Modelling and Up-Scaling:
- Model how well RS systems can distinguish the site spectra from the background signal
  - Simulating density variations
- Find out at what spatial and spectral resolution, and at what range of wavelengths, a remote system must operate to successfully distinguish each site?
- Create synthetic models to describe sites of different characteristics, then forward modelling the results of remote imaging spectroscopy (up-scaling)
Perform manual (guided) and automatic site detection

- Potential feature types:
  - Topographic features:
    - Negative/positive topographic features
    - Concentrations of stones and clearance cairns indicating the presence of architectural structures
  - Spectral features:
    - Ploughed-up habitation layers
    - Concentrations of pottery and building material
WP 2: Methodology (1)

- Methodology of WP1 supplemented with advanced spectral unmixing (MESMA) (1) and advanced LiDAR processing (2) techniques

Very similar response
Extraction of vertical structure profiles from LiDAR data

Visualisation of the 10 percentile height /intensity profile:

- 100 % (max height) (R)
- 50 % (median height) (G)
- 0 % (min height) (B)
WP 3: Background & Aims

• Operational dataset calibrated within the first two WP’s needs to be validated using:
  • Appropriate univariate and multivariate statistical analysis
  • Field checking of potential site targets

• Aims
  • Show how good/efficient methods are for detecting new sites and identifying “false positives”
    ( = INTERNAL VALIDATION)
  • Evaluate whether methods can be exported to the Hungarian Plain (evaluate how universal they are)
    ( = EXTERNAL VALIDATION)
  • Information on the effects of landscape characteristics
Innovative aspects ANAGHLIA project

- Application of hyperspectral and LIDAR RS to a rather unexplored discipline such as archaeology. Especially the integration of both data types is very innovative.

- Non-invasive RS techniques have the potential to discover sites prior to further destruction and that are not detectable by other means.
  - We can say something about the risk of further destruction.

- The comparison of different study areas will make the outcomes (or the procedures?) more robust.

- The application of “external” techniques within archaeology may advance technological development within the discipline itself.
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