RESEARCH Summer School

Remote Sensing Techniques in Cultural Heritage
Rethymno, Crete, Greece 21-26 September 2020

Abstracts

Introduction to RESEARCH projects and Summer School Presentation

Stefano De Angeli, University of Tuscia

The objectives of the RESEARCH project will be illustrated starting from a brief description of anthropic and environmental pressures that impact on the archaeological sites with buried and exposed structures, and from the analysis of opportunities that the different remote sensing and GIS technologies offer for monitoring and risk assessment of these threats. In light of this premise, the various interventions that will animate the five days of the Summer School will be illustrated.

Risk assessment methodology and scientific requirement of the RESEARCH platform

Fabiana Battistin, University of Tuscia

RESEARCH Project designed an innovative methodology to produce risk assessment for archaeological sites threatened by soil-related pressures, that are in particular land movement, soil erosion, and land use/cover change. This methodology is based on the general principle that risk is the product of multiple factors, i.e. hazard, exposure and vulnerability. The innovative elements of RESEARCH methodology consist in the actual combination of the pressures with the elements at risk, and in the procedures applied to reach this goal. Aiming at creating a methodological frame for the various lectures that will be done in the Rethymno RESEARCH Summer School, this introductive presentation will illustrate the RESEARCH methodology through the workflow of the RESEARCH System and the scientific requirement of the RESEARCH Platform.

Applications of soil erosion estimation for archaeological sites: from literature review to practice

Nikoletta Papageorgiou, Cyprus University of Technology, Cyprus

Soil erosion is a natural phenomenon and one of the most significant environmental issues, as it seriously threatens archaeological sites and monuments. The intensive agriculture practices and the impacts of climate changes can be accelerated and intensified the soil erosion, thus reducing the ability of soils to

preserve the buried archaeological heritage and producing significant negative consequences on the conservation of cultural heritage.

In recent years, several models have been used in the in the relevant scientific literature in order to estimate soil erosion rates. The models range from empirical to physical or process-based and differ significantly in complexity, accuracy, inputs and outputs. Among these, the Revised Universal Soil Loss Equation (RUSLE) has become the most commonly used in different environmental conditions and on varying scales. The present study was conducted to calculate average annual soil erosion in terms of spatial and temporal patterns by using the Revised Universal Soil Loss Equation (RUSLE) model, combined with Geographic Information Systems (GIS). This study also implemented satellite remote sensing images and available data sources such as meteorological data, a digital elevation model (DEM), land use and soils maps for soil erosion analysis. The whole methodology is based on the estimation of soil loss per unit area and takes into account specific parameters such as rainfall factor, steepness and slope length factor, cover management, practice factor as well as soil erosion factor.

ALS-based DEM for soil erosion modelling: Pomerania (Poland) test case

Sławomir Królewicz, Lidia Żuk, Adam Młynarczyk, Włodzimierz Rączkowski, Filip Wałdoch

University of Poland

The aim of this presentation is to assess the usefulness of various source of data to estimate potential threats to archaeological heritage caused by soil erosion in the Pomerania region (northern Poland). Its starting point is the Universal Soil Loss Equation (RUSLE) erosion model which takes into equation four parameters: rainfall erosivity, soil erodibility, slope length and steepness and cover management. Following this, we will analyse pros and cons of data which have already been obtained for the RESEARCH project. These include DEM derived from ALS, digital soil-agricultural maps, meteorological records and Sentinel-2 imagery. ALS-derivatives will be used both as an independent source of data and a reference point to correct and/ or process other data (Sentinel-2 imagery, soil maps). We will also discuss preliminary results obtained from processing these data in view of the RESEARCH objectives. We hope that the ensuing discussion will help establish the best practice for soil erosion analysis within large areas characterised by differentiated land use. Our results and initial conclusions may be also disseminated on the project's platform to encourage their further development.

Assessing Soil Erosion in Falerii Novi

Federico Valerio Moresi, University of Tuscia

The soil erosion, is a phenomenon that has a negative impact on ecosystem services and it can seriously menace and damage the historical landscapes. The evaluation of the sediment production and the

identification of the areas with the greatest Erosion risk is one of the important applications of GIS and GRASS systems. Grass 7.6-CVS has been used to apply the model most used today in the study of soil erodibility, RUSLE, and to evaluate the rate of erosion and net deposition using the model USPED. And also, it was possible to test the erosion pattern and SIMWE sediment transport (Mitasova et al., 2002) which is a theoretical evolution of USPED. The archaeological site of Falerii Novi (Central Italy) was used as a case study in order to apply some of these models, compare them and evaluate their advantages and disadvantages. The methodologies used highlight the importance of protecting cultural heritages and how it is possible to use a territorial information system (GRASS-GIS) for the integration of different models that simulate slope erosion processes.

The FAIRification process of remote sensing, environmental and archaeological data for the RESEARCH Data Management Plan

Fabiana Battistin, Marcella Barone – Tuscia University, Italy

The European Commission considers that it should not be necessary to pay for publicly funded information whenever one wishes to access or use it. Therefore, in order to respond to this policy, H2020 beneficiaries have the obligation to disseminate data and research results in 'Open Access', in any thematic area, as a fundamental step towards Open Science, recognizing, however the principle “as open as possible, as closed as necessary”. Article 29.2 of the Grant Agreement regulates legal obligations relating to the open-access of scientific publications in connection with H2020 projects. This lecture aims at explaining the main concepts related to Open Access policy in H2020 and to illustrate the data management plan produced within RESEARCH, as an example for data FAIRification (making data Findable, Accessible, Interoperable, and Reusable) and data reuse, in order to create a broader awareness of the role played by open science in the present and future European research.

The use of geoinformatic approaches to explore the archaeo-environment

Nasos Argyriou, Foundation for Research and Technology, Greece

The physical attributes of the Earth’s surface consist of diverse factors able to influence the local topography and in extension the human presence in those regions. The evaluation of the geomorphological setting of a region can provide valuable information on various earth sciences fields but also in archaeological landscape research. Earthquakes, landslides, flooding and other natural disasters can become devastating to humans but in addition to cultural heritage sites. The planning towards the disaster risk reduction by such natural hazards, through the investigation of the landscape characteristics, can be advantageous by the use of advanced information technology such as geoinformatics. Geoinformatics can integrate diverse datasets and

help to assess the impact of the landscape characteristics to humans and cultural heritage sites. Such valuable information can provide a powerful tool to decision makers and relative scientific sectors.

Using GPR data for the vulnerability assessment of archaeological deposits

Giancarlo Pastura -Tuscia University,
Matteo Serpetti, Philip Fayad – Alma Sistemi SRL, Italy

The application of remote sensing methods and techniques in archaeology begins to spread in the last decades, especially for their ability to show the presence of buried evidence, through the interpretation of specific variations of the physical parameters of the ground. The geophysical methodology of Ground Penetrating Radar (GPR) in the site of *Falerii Novi* has enabled on several occasions to detect the remains of the ancient occupation of the city. In particular, the GPR allows mapping geophysical anomalies at different depths (time-slices), thus permitting to measure the depth of the archaeological deposit. Inside the RESEARCH project, the GIS platform collects all these raster data forming a database, and it processes them with specific applications, in order to create a DTM model of the buried archaeological deposit top interface. This result constitutes the premise for the subsequent realization of archaeological vulnerability maps, which include archaeological heritage both preserved above the soil surface and underground. Vulnerability maps are essential for the risk assessment process created inside the RESEARCH GIS platform, which allows, through automatic encoded applications, for the generation of final risk maps for Soil erosion, Land movement and Land use change hazards.

Agent-Based Modeling Approach on Simulating Past Societies and their Social Organization

Aggelos Hliaoutakis, Foundation for Research and Technology, Greece

Some of the most interesting questions one can ask about early societies are about people and their relations, and the nature and scale of their organization. In this presentation, we attempt to answer such questions using ideas mainly from multi-agent systems, game theory, and agent-based modeling. Specifically, we provide a generic agent-based model (ABM), AncientS-ABM, for simulating and evaluating the potential social organization of an artificial ancient society, configured by available archaeological data. The ABM framework includes completely autonomous, utility-based agents and also incorporates different social organization paradigms, different decision-making processes, and also different cultivation practices used in ancient societies. The ABM also blends ideas from evolutionary game theory with multi-agent systems' self-organization. We model the evolution of social behaviours in a population of strategically interacting agents in repeated games where they exchange resources (utility) with others. The results of the games contribute to both the continuous re-organization of the social structure, and the progressive adoption of the most successful agent strategies. In addition, AncientS-ABM is able to also simulate societies inter-community interactions, by modeling the exchange and distribution across agent communities based on different spatial interaction models, in order to explore the resulting trading

network's efficiency and its evolution at different points in time. Equipped with such paradigms, the model allows us to explore the transition from a simple to a more complex society by focusing on the historical social dynamics; and to assess the influence of social organization on agents' population growth, agent community numbers, sizes and distribution. As a case study, we employ our ABM to evaluate the impact of the implemented social organization paradigms on an artificial Early Bronze Age "Minoan" society, located at different geographical parts of the island of Crete, Greece.

Cultural heritage at the edge: How coastline change affects coastal archaeological sites and how remote sensing tools can help with coastal risk assessment

Evangelos Alevizos, Foundation for Research and Technology, Greece

The coasts are naturally highly dynamic environments, meaning that they are subject to constant change over different time scales. The impact of coastline change varies with the morphology of the coast (both offshore and onshore) and the type of material on the coast (e.g.: sand, pebbles). In addition, climate change causes accelerating sea-level rise and increased occurrence of extreme phenomena (such as storm surges) that tend to amplify the impacts on coastal communities due to erosion and sea inundation. As a result, coastal archaeological sites face the risk of being irreversibly affected due to coastline change. However, modern remote sensing techniques offer a number of solutions for assessing, monitoring and predicting coastline change at various spatio-temporal scales. State-of-the-art technology such as drones and remote controlled surface vehicles are applied for monitoring coastal erosion and offshore bathymetry. Analysis of historical satellite imagery reveals the rate of coastline change at annual scale. Thus, by collecting and analysing coastal geomorphology data and time-series of satellite imagery coastal change risk can be sufficiently quantified and thus help in prioritizing responses at sites running higher risk of being impacted by coastal change.

Hands on Training - Overview of EO data manipulation through ERDAS IMAGINE

Christos Kontopoulos – Geosystem Hellas

Main features and ribbon tools, as well as spatial models of ERDAS IMAGINE desktop application will be showcased for the task of creating stacked multispectral composites of Sentinel 2 data. Basic remote sensing applications such as spectral indices will be applied on the generated data

Hands on Training - LiDAR for Archeology:
Visualization, classification and investigation of Archaeological traces

Christos Kontopoulos – Geosystem Hellas

2D and 3D visualization techniques will be examined on sample point cloud datasets. Further processing capabilities such point cloud classification and RGB encoding will also be examined. The processed output should be presented in a 3D GIS environment

Coastal archaeological sites of Crete. Threats and advantages. The case of Elounda, ancient Olous

Theotokis Theodoulou - Ephorate of Underwater Antiquities Greece

Crete is located on the so-called Greek Arch, a fact that causes a dynamic geological history of the island with a lot of tectonic movements when the eustatic ones also affect the process. This resulted to an uplift of the western half of the island when at the same time the eastern one sinks gradually but not subsequently, since more factors alter the submerging procedure in different blocks. Therefore, several archaeological sites established in low coastal zone are now partly submerged. More than thirty such sites are known to the Ephorate of Underwater Antiquities, including submerged structures of public and private buildings, villas, city walls, harbour installations, saltpans, fish tanks, etc. One of the most representative examples is the site of ancient Olous (Elounda bay), where a common geo-archaeological survey project of the Ephorate and the Institute of Mediterranean Studies has been conducted from 2017, mapping and recording the city's submerged urban center remnants, several submerged building complexes around the Gulf of Elounda, quarries on the coast of Kolokytha peninsula and even relics of ancient or pre-modern shipwrecks

The presentation will focus on the results of the project and the natural and human factors that consist threats for the site but also the advantages that coexist for measures of protection and the development of the site to an underwater archaeological park.