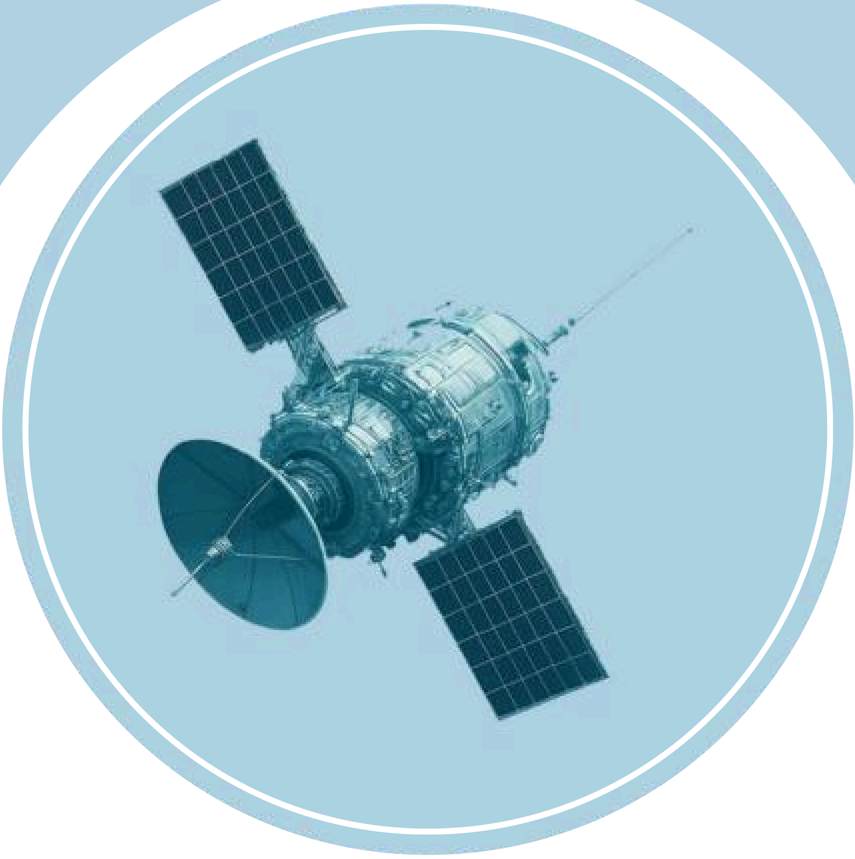


SATCULT

PROTECTING CULTURAL HERITAGE ASSETS FROM SPACE: THE POTENTIAL OF UTILISING EARTH OBSERVATION AND SATELLITE DATA

GOOD PRACTICES

media k
Consiglio Nazionale delle Ricerche
ISPC Istituto di Scienze del Patrimonio Culturale
ERATOSTHENES CENTRE OF EXCELLENCE

SATCULT - Vocational Training Closing the Knowledge Gap on Satellite-based Services for Cultural Heritage Preservation

August 2025

Co-funded by the European Union

This project has received funding from the European Union's Erasmus+ Programme KA210-VET - Small-scale partnerships in vocational education and training.
Project No. 2024-1-DE2-KA210-VET-000244931.

Contents

Greeting

The EU protecting Cultural Heritage is now visible from Space

Our European cultural heritage is increasingly under threat from climate change, natural disasters, conflicts and illicit trafficking. This makes its protection and preservation more important than ever. The European Commission is proud to be part of these efforts and actively engages in supporting various initiatives, demonstrating our commitment to safeguarding cultural heritage, especially for future generations.

Protecting cultural heritage from space may sound surprising, but Earth Observation and the use of satellite data is set to play a major role in optimising cultural preservation efforts, safeguarding heritage and enriching our cultural understanding and resilience. Applying the world-class European Copernicus and Earth Observation tools to the cultural heritage sector is a great example of the innovative application of cutting-edge space technology in the preservation of heritage while addressing modern challenges to cultural heritage conservation. And this good practice encourages the development of corresponding skills and interdisciplinary exchange of experts from the fields of cultural heritage and geoinformation.

The EU-funded **SATCULT** project is set to make a significant contribution. The examples collected in this brochure clearly demonstrate how Earth Observation can help protect cultural heritage from the consequences of climate change; help track and assess changes affecting heritage sites; record war damage; and combat looting and the illicit trafficking of European cultural artefacts.

I am delighted that the EU can support such an important forward-looking initiative through its Erasmus+ programme, and I am sure that this brochure will attract attention from both the cultural heritage professionals and the geoinformation experts.

Glenn Micallef
EU Commissioner for
Intergenerational Fairness,
Youth, Culture and Sport

“…it is hard to imagine how the challenge of effective site preservation and management, in times of climate change, mass tourism and increasing environmental hazards, should be addressed without the full integration of remote sensing capacity into EU-wide heritage management practice **1**.”

SATCULT

How Cultural Heritage Institutions Can Benefit From Satellite Data

The manifold possibilities of using satellite images have not yet arrived in the cultural heritage sector. The European project **SATCULT - Vocational Training closes the knowledge gap on satellite-based services for the preservation of cultural heritage** wants to change this because most of all, there is a lack of qualified personnel who can evaluate satellite images and translate them into protective actions. In **SATCULT**, three European institutions are preparing innovative vocational training programmes for the use of satellite data for the protection of European cultural heritage. Expertise in the fields of cultural heritage protection and geoinformation data will be linked in response to the challenges posed by climate change, illicit trafficking of cultural heritage goods and war destruction.

The **SATCULT** team collected **12 Good Practices** that show what possibilities there are. It brings together projects and initiatives that demonstrate, on the one hand, how satellite data can be used preventively. On the other hand, the Good Practices also show how Earth Observation and satellite data can be used as effective tools for damage assessment, repairs, and restoration.

In a second step, the **training needs in the cultural heritage sector as well as in the geoinformation sector** are recorded, and learning content is defined. The third step is to **create a pool of European experts** who would be willing and able to support cultural heritage institutions in their protection efforts with the respective data.

The **interdisciplinary approach** aims to facilitate joint practical applications: cultural heritage experts and geoinformation specialists are encouraged to collaborate in ways that have so far been limited to selected research projects. Finding a “common language” is one of the major challenges. The ambition of **SATCULT** is to **record the corresponding qualification requirements and translate them into training content**.

Karin Drda-Kühn
SATCULT coordinator

1 Bonora et al. 2020. “Report on the user requirements in the Copernicus domain to support Cultural Heritage management, conservation and protection”, page 49.

State of the Art from the View of Climate Change

Climate change poses a significant threat to all forms of cultural heritage, from renowned World Heritage Sites to small countryside chapels, historic industrial sites, and gardens. The most immediate dangers arise from extreme climatic events such as severe precipitation, prolonged heat waves, droughts, strong winds, and rising sea levels. These events, which are expected to become more frequent and intense according to the Intergovernmental Panel on Climate Change, lead to immediate consequences like floods, forest fires, and erosion, impacting both tangible and intangible cultural heritage across Europe.

In addition to these catastrophic events, gradual climate changes also pose a threat. Continuous increases in temperature, fluctuations in humidity, and freeze-thaw cycles cause materials to degrade and even to become destroyed, necessitating more frequent restoration and conservation efforts.

To address these challenges, the **heritage community must leverage advanced technologies**. Currently, Earth observation tools and satellite imagery are underutilized in protecting cultural heritage from climate change. There is a pressing need for the heritage sector to gain better access to these technologies. By harnessing big data from satellite measurements and monitoring, and combining it with tools like artificial intelligence and high-performance computing, **the heritage community can develop cost-effective, user-driven solutions through coordinated international efforts**.

The Erasmus+ project **SATCULT** directly addresses the urgent challenges outlined in the EU OMC report "Strengthening Cultural Heritage Resilience for Climate Change." Responding to the documented needs of the heritage sector, the project aims to unlock the potential of Earth observation technologies for cultural heritage protection. By introducing innovative applications of satellite data and advanced digital tools, the **SATCULT project will empower the heritage community with cutting-edge solutions**. Through this European funded project, **SATCULT** will make a substantial contribution to the sustainable preservation of cultural heritage in the face of accelerating climate change.

Johanna Leissner
Chair of the OMC expert group of EU Member States "Strengthening cultural heritage resilience for climate change"

Satellite Remote Sensing for Cultural Heritage: from Global Observation to Local Action

In recent decades, the use of satellites to observe Earth has profoundly transformed the way we study, protect and enhance our cultural heritage. A technology born in the scientific and military fields has now become an **indispensable tool for archaeologists, conservators and cultural institutions**, offering new eyes from space capable of scrutinising the past in a discreet but powerful way. From identifying hidden archaeological sites to monitoring endangered monuments and the effects of climate change, remote sensing is establishing itself as a strategic tool in the protection of cultural heritage.

One of the most striking features of satellite observation is its ability to analyse large areas of land on a regular basis, regardless of political boundaries or access difficulties. This has made it possible to objectively **document acts of destruction and looting in war zones**. During the war in Syria, for example, satellite imagery unequivocally revealed the devastation of the Roman site of Apamea and the destruction of the Temple of Bel in Palmyra, making visible to the world damage that would otherwise have remained invisible

However, the contribution of remote sensing is not limited to emergencies. Even in times of peace, **satellite technologies offer continuous, non-invasive monitoring of cultural heritage**. A notable example is the SyPEAH project, launched in 2023 by the Italian Space Agency in collaboration with the Colosseum Archaeological Park. It uses radar data from the COSMO-SkyMed constellation to monitor potential structural subsidence of the Roman amphitheatre. Similar observations are underway across Europe and the Mediterranean, where data from the European Copernicus programme's Sentinel satellites are being used to **assess environmental changes that could threaten monuments, cultural landscapes and archaeological sites**.

Climate change is one of the most serious – and often most silent – threats to cultural heritage. Coastal erosion, rising sea levels, more extreme weather events, and progressive desertification are already taking a toll on historic sites throughout the Mediterranean basin. Studies conducted in Libya, Egypt and Italy show how entire sections of historic coastlines are at risk, and how ancient monuments are suffering from infiltration, structural collapse, and deformation due to increasingly rapid environmental changes. Thanks to satellite imagery, these **phenomena can be detected, analysed and addressed in advance, allowing for timely interventions to safeguard cultural heritage**.

Finally, there are examples of how **observation from space has led to real archaeological discoveries**. In Egypt, Syria, and more recently in Italy and Greece, the analysis of multispectral and radar images has made it possible to identify buried structures, forgotten roads and traces of ancient settlements, often inaccessible or unknown. Innovative projects are now exploring the use of artificial intelligence to automate this research, opening new horizons for historical knowledge. Taken as a whole, **satellite remote sensing is a fundamental resource for addressing the current challenges of conservation**: it helps us discover what is hidden, monitor what is fragile, and prevent what could be lost. It is a tool that not only allows us to see the past, but also helps us to protect it for the future.

However, to fully unlock the potential of these technologies, their **integration into national and international heritage management strategies is essential**. This requires not only technological investments but also **interdisciplinary collaboration, capacity-building, and the development of open data policies that promote accessibility and transparency**. In this way, satellite remote sensing can move from being a promising tool to becoming a standard practice in the sustainable management of cultural heritage.

Nicodemo Abate
Consiglio Nazionale delle Ricerche (CNR)

Opportunities from Earth Observation in Cultural Heritage: Research and Management

Earth Observation (EO) has become a powerful tool for the documentation, monitoring, and preservation of cultural heritage, serving both scientific research and heritage management purposes. The growing availability of high-resolution satellite imagery, frequent revisit cycles, and advanced remote sensing techniques enables public and private stakeholders involved in heritage conservation to access timely, large-scale, and non-invasive data. These capabilities support informed decision-making, long-term monitoring, and the safeguarding of cultural assets with worldwide coverage.

1. **Documentation and Mapping of Heritage Sites**
   - High-resolution imagery enables the accurate mapping of archaeological and cultural sites.
   - EO facilitates the discovery of undocumented or buried heritage features through spectral and temporal analysis coupled with the application of remote sensing algorithms and, lately, with the application of Artificial Intelligence (AI).
   - Helps study and monitor heritage assets in remote or politically sensitive regions.
2. **Monitoring Natural Threats**
   - EO supports long-term monitoring of natural hazards (e.g., floods, erosion, vegetation overgrowth) threatening heritage sites.
   - Detects climate-induced risks such as desertification, sea-level rise, and changing vegetation patterns.
   - Enables risk assessment and adaptive management strategies through continuous temporal data.
3. **Detection of Human-Made Threats**
   - Identification of illegal excavations, looting, or vandalism through change detection and AI-driven algorithms and visual analysis.
   - Monitoring of urban sprawl, infrastructure development, or agriculture and residential encroaching upon protected heritage zones.
   - Supports enforcement and policymaking with spatial evidence of site degradation.

4. **Support for Restoration and Conservation**
    - Provides before-and-after views to assess the impact of restoration interventions.
    - Aids in planning by offering topographic and environmental context to guide preservation strategies.
5. **Policy Development and International Cooperation**
    - Supports international and national heritage bodies and authorities in assessing site preservation status.
    - Provides evidence-based inputs to Cultural Heritage Impact Assessments.
    - Enhances cross-border collaboration for transnational heritage landscapes and conflict-zone monitoring.

Opportunities from Earth Observation in Cultural Heritage: Careers

- Remote sensing specialist for heritage agencies, research institutes, academia, or international organisations (e.g., UNESCO, ICOMOS).
- GIS analyst working on the spatial documentation and mapping.
- Data scientist developing AI models to detect and monitor changes and dynamics using EO data.
- Risk analyst using satellite imagery to assess threats (natural and human-induced).
- First responder expert in EO analysis for disaster mitigation.
- Policy advisor or consultant on heritage protection strategies informed by EO data for governmental or NGO programs.

Opportunities from Earth Observation in Cultural Heritage: Business

- Heritage tech start-ups offering EO-based monitoring tools for site managers, insurance companies, or heritage institutions.
- EO service providers creating tailored change detection or site-mapping solutions for cultural heritage clients.
- Training and capacity building businesses developing courses or workshops on using EO tools (e.g., Google Earth Engine, Sentinel Hub) for archaeologists and conservators.
- Software development focused on apps or platforms integrating EO data for virtual heritage tours, 3D reconstructions, or site management.
- Consulting firms supporting heritage impact and Life Cycle assessments for infrastructure development using EO analytics.

Dante Abate
Eratosthenes Centre of Excellence

The SATCULT Interdisciplinary Expertise - Consortium and Advisory Board

media k GmbH is a German **social enterprise** that has been actively involved as enabler, facilitator, and service provider in cultural heritage protection activities and the development of respective training for more than 25 years: https://www.media-k.eu/

Consiglio Nazionale delle Ricerche (CNR) - Istituto di Scienze del Patrimonio Culturale (ISPC - Institute of Heritage Sciences) is the CNR's **Italian hub for research, innovation, training, and technology transfer** in cultural heritage: https://www.ispc.cnr.it/en/.

ERATOSTHENES Centre of Excellence (ECoE) is a **multidisciplinary research and innovation centre** based in Limassol, Cyprus. It specialises in Earth Observation (EO), space-based monitoring, and related digital solutions that leverage cutting-edge engineering: https://eratosthenes.org.cy/

Additional expertise from Germany, Italy and Cyprus complements the **SATCULT** team:

1. **Patricia Alberth** is Director of State Palaces & Gardens Baden Wurttemberg - Germany
2. **Daniele Gardiol** is an astronomer and researcher at INAF - Istituto Nazionale di Astrofisica in Turin / Italy.
3. **Margherita Sani** is a project coordinator at NEMO - Network of European Museum Organisations and is based in Italy
4. **Chrysanthos Pissarides** is president of the Cyprus Branch of ICOMOS.

What The Experts Say

WHY ARE EARTH OBSERVATION AND SATELLITE DATA IMPORTANT FOR CULTURAL HERITAGE PROTECTION AND WHAT CAN THESE TECHNOLOGIES OFFER?

Director of State Palaces & Gardens Baden Wurttemberg / Germany

“Earth observation and satellite data are not just technological tools—they can be strategic allies in the long-term stewardship of our cultural treasures”

Patricia Alberth

“Space-based Earth observation offers a powerful way to monitor and protect cultural heritage by providing comprehensive territorial coverage and consistent, long-term observation”

Daniele Gardiol

INAF – Istituto Nazionale di Astrofisica in Turin / Italy

Climate change expert / Germany

“Climate change is impacting cultural heritage profoundly. Satellite technology will be indispensable to cope with the challenges to protect our heritage”

Johanna Leissner

“Best practices in Earth Observation, supported by ICOMOS’s principles, are crucial for monitoring, safeguarding, and sustainably managing our global cultural heritage. Leveraging these advanced techniques enhances preventive conservation, informed decision-making, and resilience against threats”

Chrysanthos Pissarides

Cyprus Branch of ICOMOS

What The Experts Say

NEMO – Network of European Museum Organisations

"Earth observation and satellite data allow for monitoring of cultural sites, but also to detect buried or otherwise invisible archaeological features that traditional ground-based methods might miss"

Margherita Sani

"Earth observation and satellite data enhance our capabilities to safeguard cultural heritage in a more holistic and efficient way, supporting knowledge-based policies and actions to address the vulnerabilities of cultural heritage sites and landscapes against natural and anthropogenic threats and ensuring their transmission to future generations"

Erminia Sciacchitano

CHARTER Advisor / Italy

Professor of Physical Geography Heidelberg University of Education and Heidelberg University

"Changes, as caused by climate change, urbanization, or environmental problems often occur slowly, making their impacts on cultural heritage barely visible to the human eye. "Making the invisible visible" — this is the unique potential of Earth Observation with the "view from above": Multitemporal, multiresolutional and multispectral"

Alexander Siegmund

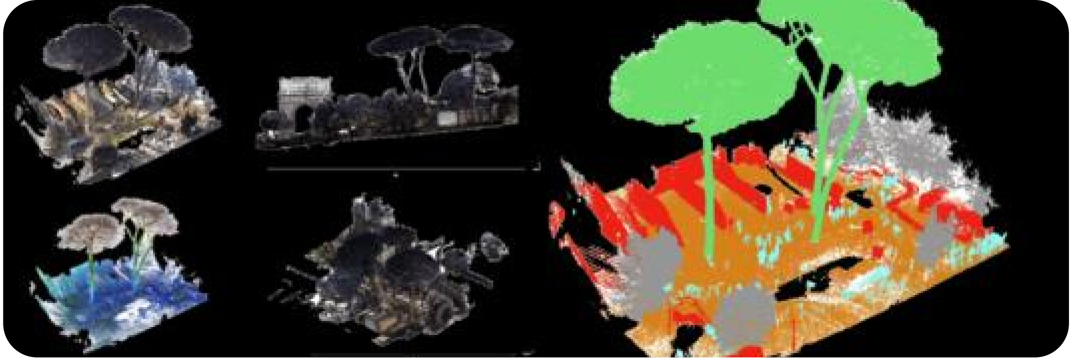
"The integration of EO technologies with conventional field archaeology revises the ways we approach cultural landscapes, enabling us to not only uncover remnants of premodern human activity but also evaluate diverse risks and promote a sustainable management of our cultural heritage"

Athanasios K. Vionis

Associate Professor of Byzantine Archaeology and Art University of Cyprus

SPACE TO TREE: EARTH OBSERVATION BASED MONITORING OF NATURAL AND HISTORICAL PARKS

Organisation	Digimat s.r.l., Consiglio Nazionale delle Ricerche - Istituto di Scienze del Patrimonio Culturale & Istituto di Metodologie per l'Analisi Ambientale
Country of Application	Italy
Type of Organisation	Research Institute
Responsible Person	Nicola Masini
Description of the Good Practice	The S23 project offers a climate-smart, scalable approach to managing historic urban green spaces like the Colosseum Archaeological Park. It integrates Earth Observation (EO), IoT, and AI technologies to monitor vegetation health and detect early signs of climate stress. Sentinel-2 data processed via Google Earth Engine provides NDVI analysis, while machine learning identifies phenological changes at the pixel level. Drone imaging, GPR, and thermal sensors enhance multi-scale monitoring. Real-time IoT sensors and 5G telemetry enable continuous biodynamic data collection. Results are shared through an interoperable WebGIS, supporting timely decision-making and research. The system is open-source, non-invasive, cost-effective, and aligned with UNESCO guidelines, promoting sustainable heritage management and citizen engagement.
Special Skills Required	Remote Sensing & Earth Observation; Google Earth Engine (GEE); Machine Learning for Remote Sensing; WebGIS and Platform Development; IoT & Environmental Sensor Networks; Data Analysis & Data Integration. All the skills required were already present within the organization.
Benefits and Impact	The S23 project has proven effective at the Colosseum Archaeological Park, supporting the planning and maintenance of tree heritage while enhancing the historic landscape. By enabling early detection of climate-related risks, it reduces the need for costly emergency interventions and supports targeted, timely restoration. Its integration of satellite and close-range data allows for accurate, non-invasive monitoring of vegetation health, ideal for complex settings where natural and cultural heritage intersect. Developed through collaboration between CNR-ISPC, CNR-IMAA, Digimat, and ESA, the platform offers a scalable, multidisciplinary solution. It is currently used at the Colosseum Park to manage green areas and assess environmental risks:



- Lower emergency interventions costs
- Lower ordinary management costs, with preventive maintenance as a fundamental prerequisite for sustainable conservation
- Increasing accessibility of knowledge.

Moreover, by allowing early detection of climate-related risks, the system minimizes the need for costly emergency interventions and facilitates timely, targeted restoration

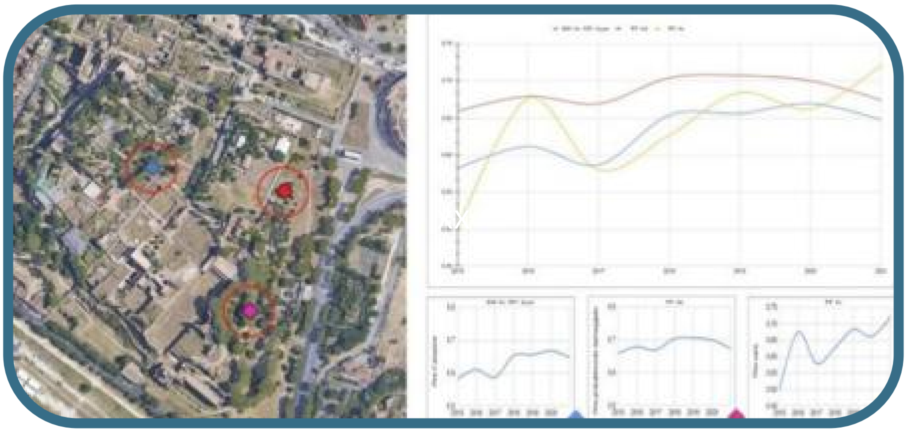
In conclusion, the S23 Project applied to Colosseum Archaeological Park illustrates how the integration of innovative monitoring technologies with preventive conservation strategies can deliver sustainable, cost-effective, and socially valuable solutions for protecting cultural landscapes at risk.

Transfer Potential to Other Heritage Sites and Organisations

The Space to Tree project was conceived and designed as a model to be reapplied, scaled and modified according to the different needs of other cultural and natural sites.

Its modular structure allows easy adaptation to different environmental and cultural contexts, supporting both large-scale and site-specific monitoring.

The involvement of public research bodies and ESA ensures scientific robustness, while its success at the Colosseum Park demonstrates its practical value and replicability.



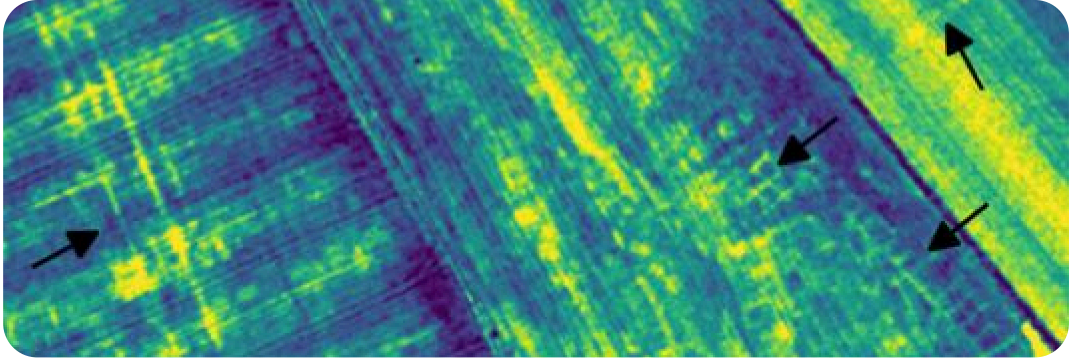
Satellite-based time-series analysis of vegetation health indicators for selected monumental trees in the Colosseum Archaeological Park – Space-to-Tree Project

Further Information

N. Masini et al., From Space to Tree: multisensor and multiscale remote sensing based approach for monitoring monumental trees. The case of archaeological park of Colosseum in Rome. Preliminary results. In 2023 IMEKO TC4 International Conference on Metrology for Archaeology and Cultural Heritage, 2023. https://doi.org/10.21014/tc4-ARC-2023.035

Contact nicola.masini@cnr.it

Picture Credits The images were produced as part of the Space to Tree Project as part of the project outputs, by Digimat srl and CNR - ISPC, CNR - IMAA.



PRESERVING CULTURAL HERITAGE OF AQUILEIA AND ITS TERRITORY

Organisation	Istituto Italiano di Tecnologia		
Country of Application	Italy	**Type of Organisation**	Research Institute
Responsible Person	Arianna Traviglia		

Description of the Good Practice

This Good Practice emerged from the need to better understand and manage the archaeological landscape within a rapidly transforming territory. With increasing pressures from urban expansion and land-use changes, it became crucial to develop a method that supports both archaeological research and heritage preservation.

The primary aim was to expand the archaeological trace map within the territory, with a focus on improving the understanding of past human-environment interactions and informing more sustainable land-use decisions. The practice was guided by three interrelated objectives:

(1) Enhancing the study of landscape evolution through a diachronic perspective.

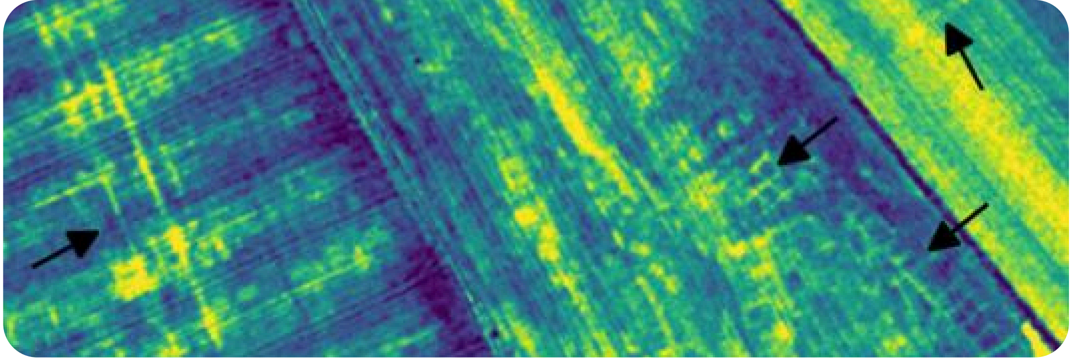
(2) Creating a comprehensive map of buried and surface features to support archaeological research.

(3) Serving as a practical tool for heritage protection in the context of land-use planning.

The practice made use of datasets from the Copernicus Programme, particularly Sentinel-2 multispectral imagery accessed through the Copernicus Open Access Hub and Google Earth Engine, as well as PRISMA hyperspectral satellite data from the ASI portal. Historical aerial photographs were also sourced from the regional cartographic server and directly requested from the archives of the Regione Friuli Venezia Giulia.

Special Skills Required

The work requires a blend of technical, analytical, and interdisciplinary skills, including remote sensing and GIS analysis, image processing, archaeological and landscape analysis, machine learning, project management, and effective interdisciplinary communication.



Benefits and Impact	The integration of AI-driven remote sensing technologies provides significant benefits to cultural heritage assets by enhancing detection, monitoring, and preservation efforts. Automated analysis through machine learning accelerates the identification of archaeological features, including buried structures and past landscape modifications, reducing reliance on time-consuming manual interpretation. The use of multimodal data fusion, combining satellite imagery, historical maps, and hyperspectral data, allows for a more comprehensive understanding of site evolution, improving historical reconstructions and conservation strategies.
Transfer Potential to Other Heritage Sites and Organisations	There is significant potential for transferring this Good Practice to other cultural heritage organisations, particularly in areas with similar environmental characteristics, such as agricultural landscapes, wetlands, and regions prone to seasonal changes. The use of AI-driven remote sensing technologies for detecting and monitoring archaeological features is highly adaptable and can be applied to diverse settings, as long as the local environmental and landscape conditions share similarities.
Further Information	https://doi.org/10.3390/geosciences7040128 https://doi.org/10.36227/techrxiv.172833109.92524193/v1
Contact	arianna.traviglia@iit.it
Picture Credits	© Center for Cultural Heritage Technology, Istituto Italiano di Tecnologia

HAZARD EXPOSURE MAP FOR CULTURAL HERITAGE OF MUSEUMS AND MONUMENTS OF PORTUGAL

Organisation: Museums and Monuments of Portugal, EPE (government-owned business enterprise)

Country of Application: Portugal

Type of Organisation: Cultural Heritage Related Public Entity

Responsible Person: Esmeralda Paupério

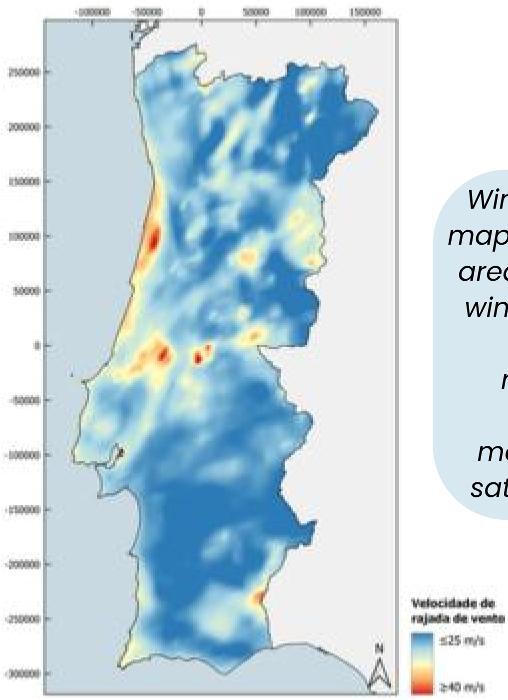
Description of the Good Practice

In the context of cultural heritage risk management, satellite data offers applications in both underpinning hazard and risk models and enabling real-time risk response. This is especially valuable for protecting cultural heritage assets, as integrating hazard maps with cultural heritage location data facilitates rapid identification of at-risk landmarks and informs targeted interventions. In the present best practice, for instance, the precipitation hazard model uses the Global Precipitation EXtremes (GPEX) dataset, which harnesses high-resolution satellite-based estimates and merges them with reanalysis data and gauge observations via the Multi-Source Weighted-Ensemble Precipitation (MSWEP) dataset, ensuring comprehensive spatial coverage and refined assessments of extreme events. Similarly, wind hazard modelling is supported by the Copernicus European Regional ReAnalysis (CERRA), where atmospheric reanalysis combines historical observations—including satellite data—with short-range forecasts to construct a physically consistent depiction of past weather. On the other hand, the Copernicus Emergency Management Service (CEMS) leverages high-resolution satellite imagery and geospatial data in real-time disaster management for perils such as floods and wildfires, enabling rapid evaluation of affected areas and coordinated emergency responses that protect both cultural heritage and broader communities.

Special Skills Required

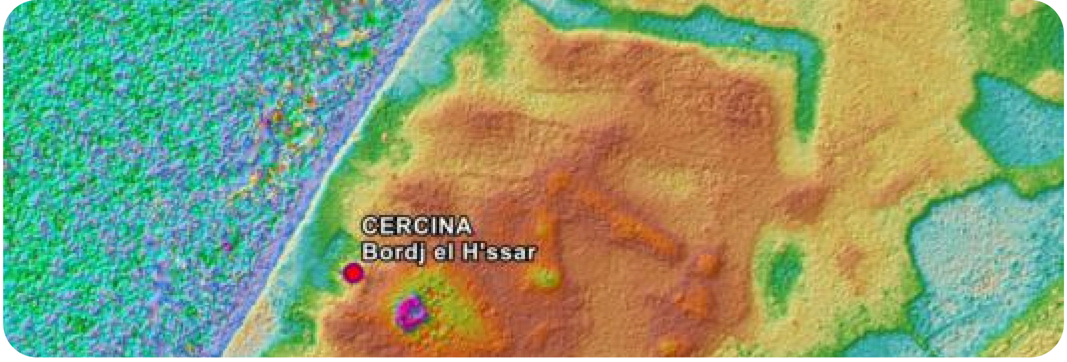
Successful implementation of this Good Practice requires a combination of technical, technological, and domain-specific skills. GIS expertise is essential for accurately overlapping and analysing various spatial data layers. Equally important is a deep understanding of the natural phenomena that drive hazards, ensuring that risk assessments and hazard maps are accurate and relevant. Additionally, integrating heritage-related insights ensures that cultural values are safeguarded by aligning technical analyses with the specific needs of heritage protection.

Benefits and Impact	Using satellite data for disaster risk management in cultural heritage is highly beneficial due to its ability to provide consistent, wide-scale, and high-resolution observations. In particular, it supports the development of risk maps and vulnerability assessments, offering critical input for preparedness and response planning. Importantly, it facilitates the documentation and monitoring of cultural heritage sites, contributing to their long-term protection and informed decision-making for disaster risk management.
Transfer Potential to Other Heritage Sites and Organisations	The transfer potential is high as long as hazard maps are available for a given region and cultural heritage is geolocated.



Wind hazard exposure map of Portugal showing areas at risk of extreme wind gusts, supporting disaster risk management for museums and monuments through satellite-derived data

Further Information	https://www.museusemonumentos.pt/en/
Contact	esmeralda.pauperio@museusemonumentos.pt
Picture Credits	© MMP, EPE



KERKENNAH ISLAND PROJECT

Organisation: Institut National du Patrimoine de Tunisie/CNRS, France

Country of Application: Tunisia

Type of Organisation: Joint Cultural Heritage-related public entity (Ministry, Tunisia) – French National Centre for Scientific Research

Responsible Person: Katia Schörle

Description of the Good Practice

Initially designed to survey sea salt preservation and its use in the Tunisian islands of Kerkennah, the project discovered the urgent challenge of coastal erosion and heritage site preservation in the face of climate evolution while using satellite imagery meant to accurately georeferenced sites. Using high-resolution Pleiades satellite imagery (0.5m) and advanced remote sensing techniques, the project discovered, monitored and quantified micro-local coastal erosion over a 10-year period (2012-2022).

By integrating the most precise GIS methods using the Digital Shoreline Analysis System (DSAS) for each coastal type and aligning calculations with GIS sea-level rise protections, the research group estimates that by 2100, up to 1/3 of the site could be at risk of loss due to erosion. These findings highlight the urgent need for adaptive management strategies to mitigate the impact of climate change on cultural heritage, providing essential data to support sustainable costal conservation efforts.

Special Skills Required

The necessary technical skills were not initially available in the organisation.

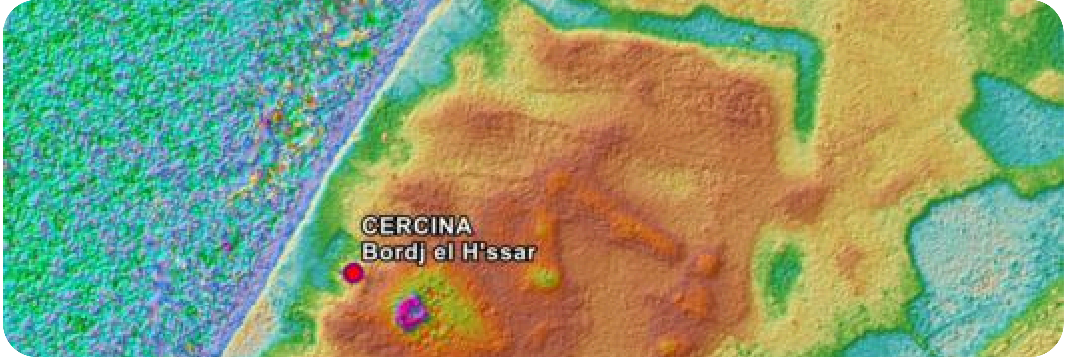
The French Space Agency (CNES) and technicians assisted and guided towards the tools needed.

Benefits and Impact

Archaeological recordings can proceed according to advanced knowledge of areas most at risk; coping strategies to protect the site can be put into place.

Transfer Potential to Other Heritage Sites and Organisations

Very high: This form of work should be required, and the Kerkennah Project was designed in a way that it could be emulated as an example of best practice elsewhere.



Further Information	Publication in preparation
Contact	Katia.schorle@cnrs.fr
Picture Credits	© CCJ, SFPT, AFRICAE, MNS Pléiades (2022), QGIS 2025. L. Diatta, K. Schorle, L. Lapierre

MONITORING CULTURAL HERITAGE SITES AFFECTED BY GEO-HAZARDS USING IN-SITU AND SYNTHETIC APERTURE RADAR (SAR) DATA: THE CHOIROKOITIA CASE STUDY

Organisation
Eratosthenes Centre of Excellence (ECoE)

Country of Application
Cyprus

Type of Organisation
Research Institute

Responsible Person
Kyriacos Themistocleous

Description of the Good Practice
The Neolithic settlement of Choirokoitia (UNESCO World Heritage) was studied to monitor geo-hazards and ground deformation. The site was analyzed using InSAR data from the COSMO-SkyMed constellation, processed with Persistent Scatterer Interferometry (PSI) for millimeter-precision motion detection. Complementary data from UAV photogrammetry, GNSS, and total stations supported the analysis. The study aimed to:
1) Detect and monitor geo-hazards at the site 2) Identify long-term ground deformation trends for conservation planning 3) Integrate satellite (InSAR/PSI) and ground-based data to enhance monitoring accuracy
4) Monitor large-scale deformations over time using satellite observations 5) Complement high-resolution 3D documentation with UAV imagery and modeling.

Special Skills Required
Expertise in InSAR data processing, UAV operation, photogrammetry, GIS, and geodetic measurements such as GNSS and total station surveys.
Advanced training in radar data analysis, multi-temporal image processing (because of the InSAR), and the integration of aerial and ground-based surveying data for comprehensive monitoring were necessary.

Benefits and Impact
The project successfully identified deformation trends at Choirokoitia, highlighting areas at risk from natural hazards. High-resolution 3D models and Digital Elevation Models (DEMs) were created. These were very useful for effective documentation and comparison over time. The methodology demonstrated to be scalable for application at other UNESCO sites.

Transfer Potential to Other Heritage Sites and Organisations
This adaptable and scalable monitoring approach can be applied to cultural heritage sites facing various geo-hazards (e.g. subsidence, landslides, earthquakes, coastal erosion, or urban encroachment). It enables the documentation of remote or inaccessible areas, is cost-effective, and supports global conservation through standardized monitoring protocols.

Further Information

Themistocleous, K. and Danezis, C., 2020. Monitoring cultural heritage sites affected by geo-hazards using in situ and SAR data: the Choirokoitia case study. Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East, pp.285-308. https://doi.org/10.1007/978-3-030-10979-0_16

Contact k.themistocleous@eratosthenes.org.cy

OPEN-ACCESS REMOTE SENSING DATASETS FOR MONITORING THREATS

Organisation	Cyprus University of Technology (CUT)
Country of Application	Spain, Baltanás, Province of Palencia, Autonomous Community of Castile and León
Type of Organisation	University
Responsible Person	Kyriakos Michaelides
Description of the Good Practice	This practice applied a unified GIS-based method to assess and visualize soil erosion risk in areas without ground monitoring. Using open-access satellite data and the Revised Universal Soil Loss Equation (RUSLE) model, all erosion factors were derived from standardized European datasets (e.g., GloREDa, SoilGrids, CORINE, ESDAC LS-factor data, ESDAC' mean P-factor dataset), enabling the development of a spatially consistent erosion risk model using visual programming techniques. Data were processed at high spatial resolution (up to 5 m) and aligned to the local UTM zone for accuracy. The approach proved effective in delivering reliable, scalable, and comparable erosion risk assessments using only publicly available data.
Special Skills Required	Technical skills, technological expertise, GIS proficiency, remote sensing knowledge, cultural heritage awareness, spatial analysis. All the skills required were already present within the organization.
Benefits and Impact	Satellite data and GIS technologies enhance cultural heritage protection by enabling early detection of risks like erosion and flooding through tools such as RUSLE, allowing for targeted conservation efforts and reducing the need for reactive measures. They support remote monitoring, change tracking, and international collaboration via shared data. Digital mapping also promotes awareness and accessibility, contributing to more effective, data-driven conservation and management of heritage sites.
Transfer Potential to Other Heritage Sites and Organisations	This Good Practice has strong potential for transfer to other cultural heritage organizations. The methodology based on open-access satellite data, GIS, and the RUSLE model is replicable, cost-effective, and adaptable to various geographic and cultural contexts.

Further Information	Please see https://satcult.eu/good-practices/
Contact	km.michaelides@edu.cut.ac.cy
Picture Credits	© ARGUS Project

INNOVATIVE STRATEGIES FOR THE ADOPTION OF RISK MANAGEMENT PLANS TO ENHANCE THE RESILIENCE OF SENSITIVE CULTURAL AND NATURAL HERITAGE OBJECTIVES AGAINST CLIMATE HAZARDS IN RIVER BASIN DISTRICTS – INACO INTERREG CE PROJECT

Organisation: Consiglio Nazionale delle Ricerche – Istituto di Scienze dell'Atmosfera e del Clima

Country of Application: European and Mediterranean Basin

Type of Organisation: Research Institute

Responsible Person: Alessandra Bonazza

Description of the Good Practice: Data and products from Copernicus services (C3S and CAMS) and IMERG are utilised for the development of maps and time series of changes in climate and pollution parameters potentially causing damage to cultural and natural heritage. Extreme variations of temperature and precipitation are elaborated in specific climate risk indices and damage functions in order to support policy and decision makers to identify hazard-prone areas in Europe and the Mediterranean exposed to hydrometeorological risks. All data are available to users through the "Risk Mapping Tool for Cultural Heritage Protection" Web-based platform (https://www.protecht2save-wgt.eu/)

The Good Practice has been designed and developed to support policy and decision makers in setting up preparedness strategies and planning actions for safeguarding cultural and natural heritage to climate change impacts.

Special Skills Required: No specific skills from a technological point of view are required. Tutorials and training courses purposely dedicated are available.

Benefits and Impact: Improvement of resilience to the impact of climate change (slow and extremes variations).

Transfer Potential to Other Heritage Sites and Organisations: The "Risk Mapping Tool for Cultural Heritage Protection" could integrate other cultural and natural heritage sites, in addition to the pilot sites already included.

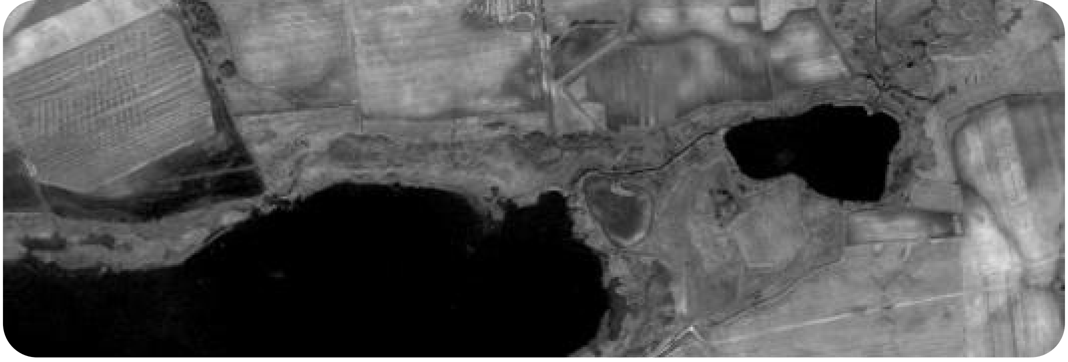
Further Information: Access to the website: https://www.interreg-central.eu/projects/inaco/

Numerous publications are available, e.g.

Bonazza A., Sardella A., 2023. Climate Change and Cultural Heritage: Methods and Approaches for Damage and Risk Assessment Addressed to a Practical Application. Heritage 6(4), 3578-3589. https://doi.org/10.3390/heritage6040190

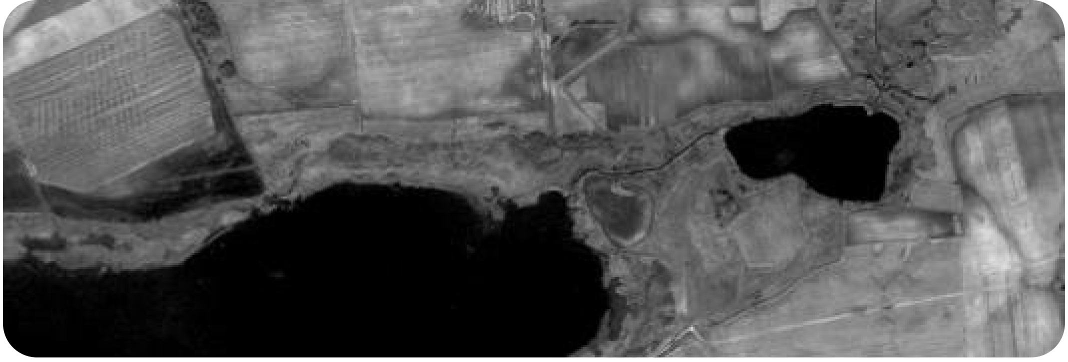
Contact: a.bonazza@isac.cnr.it

Picture Credits: © INACO Interreg Central Europe Project



TRIQUETRA: TOOLBOX FOR ASSESSING AND MITIGATING CLIMATE CHANGE RISKS AND NATURAL HAZARDS THREATENING CULTURAL HERITAGE

Organisation	Adam Mickiewicz University in Poznań
Country of Application	Poland
Type of Organisation	University
Responsible Person	Włodzimierz Rączkowski
Description of the Good Practice	Purposes of the practice were: 1) monitoring climate change on a global scale, detecting trends and changes in different geographical locations; 2) monitoring land use changes, vegetation cover, and hydrology. Useful for analysis in historic perspective (in combination with other data, e.g. meteorological). The project had to cope with a limitation of optical imagery because of clouds, which lead to irregular, random acquisition of data. Repositories used: USGS (CORONA & HEXAGON; Landsat); Sentinel HUB (Sentinel-1, Seninel-2), Planet Lab.
Special Skills Required	For an effective data-driven research a skilled, collaborative team was required, as no single individual could manage the entire process from formulating questions to processing and interpreting data across specialized fields.
Benefits and Impact	The use of satellite data will not protect an archaeological site from destruction, looting, etc. Using such data allows for assessing the scale of potential destruction. The procedure of acquisition, processing, analysis, and interpretation means that responsible institutions will always have this information post factum. However, long series of data allow for analyzing change trends and, as far as possible, preventing them or minimizing their effects. For example, this may concern changes in water levels in a lake (Smuszewo case).
Transfer Potential to Other Heritage Sites and Organisations	The Smuszewo case study is precisely aimed at developing a procedural model that can be applied by governmental bodies in the context of other sites located on the lakeshore.

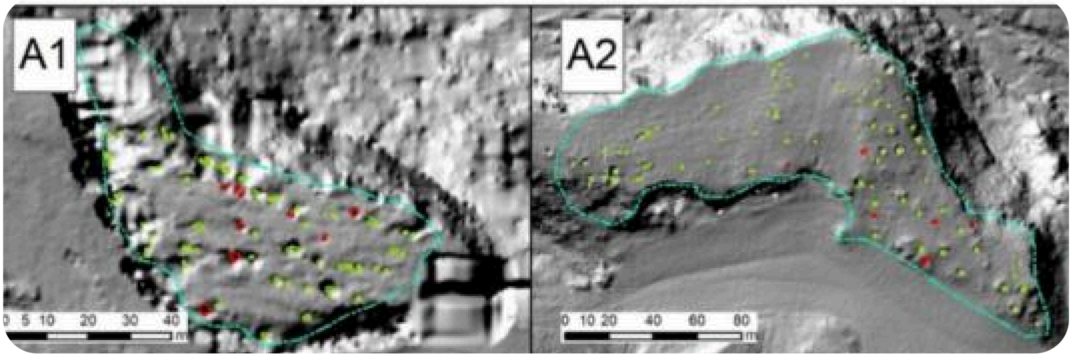


Further Information

Graf R., Kaczmarek L., Królewicz S., Rączkowski W., Żuk L. 2025, Climate Change and Archaeological Heritage: risk identification and monitoring of a lakeshore archaeological site in Smuszewo (Poland) - a case study, Italian Journal of Engineering Geology and Environment

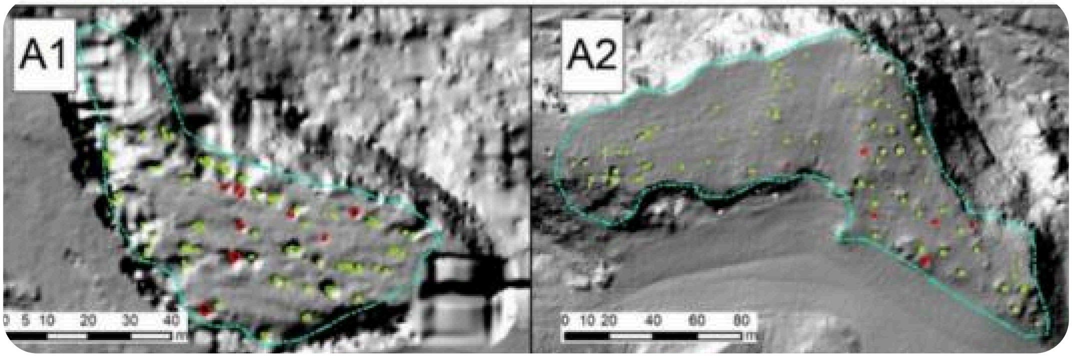
Contact wlodekra@amu.edu.pl

Picture Credits © USGS, TRIQUETRA, S. Kólewicz



PATTERN EXTRACTION METHODS AND LIDAR TECHNOLOGY FOR ANALYZING AND MAPPING ARCHAEOLOGICAL LOOTING

Organisation	Consiglio Nazionale delle Ricerche - Istituto di Scienze del Patrimonio Culturale
Country of Application	Italy
Type of Organisation	Research Institute
Responsible Person	Maria Danese
Description of the Good Practice	This Good Practice demonstrates a replicable and semi-automatic methodology for detecting archaeological looting using LiDAR-derived DTMs, particularly effective in wooded areas where optical imagery fails. The integration of advanced visualisation techniques and the Geomorphon landform classification allowed for the identification of looting pits based on their micro-topographic signatures. This method enhances the ability to monitor and quantify clandestine excavations, which are a major threat to cultural heritage.
Special Skills Required	Technical and Technological Skills: Expertise in LiDAR data acquisition and processing, including the use of full waveform scanners, point cloud filtering, and DTM generation. Proficiency in GIS software (e.g., QGIS, SAGA GIS, Relief Visualization Toolbox) and remote sensing tools was necessary to apply and interpret various visualisation techniques (VTs) such as Hillshade, Openness, and Sky View Factor. Geospatial Analysis and Pattern Recognition: Skills in spatial analysis and landform classification, particularly in applying the Geomorphon algorithm for semi-automatic detection of looting-related depressions. Understanding of topographic modelling and terrain morphology supported the interpretation of micro-relief features. Archaeological and Heritage Knowledge: A solid background in archaeology, especially in Etruscan culture and site formation processes, was vital to contextualise the findings and distinguish looting pits from natural features. Knowledge of historical looting patterns informed the selection of target areas. Field Survey and Validation: Competence in GNSS/RTK GPS surveying was required for ground-truthing and validating the remote sensing results. This included the ability to interpret topographic profiles and conduct in-situ assessments of looting evidence. Interdisciplinary Collaboration: Effective communication and collaboration among archaeologists, remote sensing specialists, and geomatics experts were key to integrating diverse methodologies and ensuring the reliability of results.



Benefits and Impact

- Early detection of looting activity enables timely intervention and increased surveillance in vulnerable areas.
- Documentation and quantification of damage support legal and administrative actions against illicit excavations.
- Remote monitoring allows for continuous assessment of hard-to-access or forested sites, reducing the need for invasive fieldwork.
- Data sharing and reproducibility foster international cooperation and the development of standardised tools for heritage protection.
- Awareness and deterrence: The visibility of such monitoring efforts may discourage future looting attempts.

Overall, this Good Practice enhances the capacity to safeguard archaeological landscapes through non-invasive, scalable, and replicable methods.

Transfer Potential to Other Heritage Sites and Organisations

- This Good Practice has strong potential for transfer to other cultural heritage organisations, especially those working in forested or hard-to-access archaeological landscapes. The methodology is based on widely available technologies—LiDAR data, open-source GIS software, and the Geomorphon algorithm—which makes it accessible and adaptable.
- Scalability: The approach can be applied to different spatial scales, from small sites to large regions, depending on data availability.
- Replicability: The workflow—from LiDAR processing to visualisation and pattern recognition—is well-documented and can be reproduced with minimal customisation.
- Open-source tools: Most of the software used (e.g., QGIS, SAGA GIS) is free and widely supported, reducing barriers to adoption.
- Interdisciplinary applicability: The method can be integrated into existing archaeological, conservation, or heritage management workflows, and adapted to different cultural contexts.
- Training potential: The approach can be taught through workshops or capacity-building programs, empowering local institutions to monitor and protect their heritage autonomously.

This practice is particularly valuable for institutions in regions where looting is a persistent threat and where traditional field surveys are limited by vegetation, terrain, or resources.

Further Information

Danese, M.; Gioia, D.; Vitale, V.; Abate, N.; Amodio, A.M.; Lasaponara, R.; Masini, N. Pattern Recognition Approach and LiDAR for the Analysis and Mapping of Archaeological Looting: Application to an Etruscan Site. Remote Sens. 2022, 14, 1587. https://doi.org/10.3390/rs14071587

Contact maria.danese@cnr.it

USING SATELLITE IMAGERY AND GEOSPATIAL INFORMATION TECHNOLOGIES (GIT) TO SUPPORT CULTURAL PROPERTY PROTECTION (CPP) IN UKRAINE

Organisation	UNOSAT in partnership with UNESCO		
Country of Application	Ukraine	**Type of Organisation**	International Organisation
Responsible Person	Michelle de Gruchy		
Description of the Good Practice	This training aimed to assess war damage to cultural heritage sites with the help of satellite data. It made participants aware of the full range of spatial and aerial/satellite imagery data available and where to find these data (various repositories, providers, etc.), as well as how to collect or create these data. The training itself focused on the use of open-source satellite imagery data and software (Google Earth Pro, Google Earth Engine, QGIS, PRISMA Toolbox) and freely available data to ensure they walked away with sustainable skills, regardless of their workplace's budget.		
Special Skills Required	Expertise in Geographic Information Technology applied to cultural and natural heritage.		
Benefits and Impact	Cultural heritage experts have increased literacy in geographic information technology and are able to conduct GIS and satellite imagery analyses to map, analyse, and monitor cultural and natural heritage sites.		
Transfer Potential to Other Heritage Sites and Organisations	Our training goal is capacity building and our aim is that the people we train will be able to pass on their knowledge to others. In this Good Practice, we provided all participants with 2 sets of 20 booklets in Ukrainian covering the training material to both (1) support their individual learning once they return home and (2) help them pass on their knowledge to others. With 2 sets of booklets, they could keep one copy for themselves as reference for their own use (direct or to refer to when teaching others) and share one copy with an interested colleague or their institution's library.		
Further Information	https://unitar.org/about/news-stories/news/unesco-and-un-satellite-centre-join-forces-safeguard-ukraines-cultural-heritage-geospatial https://unitar.org/about/news-stories/news/unosat-and-unesco-conduct-advanced-training-cultural-heritage-monitoring-ukraine		
Contact	michelle.degruchy@unitar.org		
Picture Credits	©UNESCO/Vitaliy Hrabar		

GIS-BASED ATTRIBUTE MAPPING OF UNESCO WORLD HERITAGE SITES: A CASE STUDY OF THE BADEN-WÜRTTEMBERG SECTION OF THE “PREHISTORIC PILE DWELLINGS AROUND THE ALPS”

Organisation	Heidelberg University of Education, Institut for Geography & Geo-Communication - ʳgeo, UNESCO Chair on Observation and Education
Country of Application	Germany
Type of Organisation	University
Responsible Person	Prof. Dr. Alexander Siegmund, Paul Bobsin
Description of the Good Practice	The transnational serial World Heritage Site “Prehistoric Pile Dwellings around the Alps”, inscribed in 2011 for its Outstanding Universal Value (OUV), includes 15 lakeshore and wetland settlements in Baden-Württemberg. To safeguard their OUV and ensure long-term preservation, these Neolithic and Bronze Age sites (5000–500 BC), located along Lake Constance and in the Upper Swabian wetlands, required systematic GIS-based mapping of all relevant attributes. This mapping forms a vital foundation for the ongoing monitoring, management, long-term protection, and sustainable preservation of the OUV of these pile dwelling sites. The report serves as a practical guide that provides a clear and detailed overview of the sites’ protection needs. It is intended to support heritage impact assessments and guide the evaluation of potential interventions with regard to their effects on the OUV.
Special Skills Required	GIS skills, interdisciplinary collaboration skills to collaborate with different experts from the fields of underwater archaeology, limnology and the management of UNESCO World Heritage Sites.
Benefits and Impact	Developed through a multi-step process in close cooperation with local institutions, partners, and experts, the approach involved identifying the specific values and features of the property, linking them with relevant geospatial data, assessing current and potential threats to the OUV, and formulating a comprehensive protection strategy. A central element of this strategy was the definition of the “Wider Setting” which includes all significant external factors that may influence the long-term preservation of the sites.

Transfer Potential to Other Heritage Sites and Organisations	The GIS-based attribute mapping developed for the Baden-Württemberg pile-dwelling sites established a clear, systematic catalogue of all attributes related to their Outstanding Universal Value. By providing a baseline for monitoring, management and long-term protection, it enables heritage impact assessments and supports the evaluation of potential interventions against core values. The report's structured templates and workflows can be readily adapted by other heritage authorities and organisations, offering a transferable toolkit for sustainable preservation and risk-based decision-making at diverse World Heritage sites.
Further Information	Report: "Attribute-Erfassung für den baden-württembergischen Teil der Welterbestätte. Prähistorische Pfahlbauten um die Alpen" (not published so far by the Cultural Heritage Department of Baden-Württemberg - Landesamt für Denkmalpflege Baden-Württemberg).
Contact	siegmund@ph-heidelberg.de, bobsin@ph-heidelberg.de
Picture Credits	

MONITORING OF MEADOW ORCHARDS

Organisation: Heidelberg University of Education, Institut for Geography & Geo-Communication - rgeo, UNESCO Chair on Observation and Education

Country of Application: Germany

Type of Organisation: University

Responsible Person: Prof. Dr. Alexander Siegmund, Paul Joseph

Description of the Good Practice

The Good Practice shows that satellite data can be effectively utilised for cultural heritage by integrating multiple scales of observation. Traditional orchards are valuable cultural landscapes, and combining satellite imagery with Unmanned Aerial Vehicles (UAV) data will enhance their monitoring, preservation, and management. By using open-access data and scalable methods, the project promotes cost-effective and replicable practices, making remote sensing a practical tool for long-term heritage conservation.

Special Skills Required

A combination of technical, technological and heritage skills is required to successfully implement this approach. Remote sensing expertise is essential for the processing and analysis of satellite and UAV data, including classification techniques and spectral index calculations. GIS skills are required for spatial data management and visualisation. Technological skills in UAV operation and machine learning improve data integration and accuracy. In addition, heritage knowledge is critical to understanding the cultural significance of traditional orchards and ensuring that monitoring efforts are aligned with conservation needs. Effective communication and interdisciplinary collaboration further support knowledge transfer and stakeholder engagement.

Benefits and Impact

As orchard meadows increase in ecological value over time, old and healthy meadows become increasingly valuable in terms of their contribution to ecological diversity. Our approach assists in identifying the necessity for targeted maintenance measures in orchard meadows, with the objective of ensuring the continued health and longevity of the tree population. These findings can then be conveyed to local authorities and the general public, with a view to initiating maintenance measures or the promotion of tree ownership.

Transfer Potential to Other Heritage Sites and Organisations	It should be feasible to adapt an established workflow to other cultural heritage sites facing similar challenges related to neglect and maintenance issues.
Further Information	https://www.rgeo.de/en/p/steggeo/ https://www.rgeo.de/en/p/streuobst/
Contact	siegmund@ph-heidelberg.de, joseph@ph-heidelberg.de
Picture Credits	© Research Group for Earth Observation - ʳgeo, Heidelberg University of Education

Interdisciplinary Cooperation is Key – How EO Data Contributes to the Protection of Cultural Heritage

A Short Outcome Analysis of the Good Practices

When analysing the Good Practices presented in this brochure, it is clear that **interdisciplinary cooperation at eye level** is one of the most important success factors when using satellite data to protect cultural heritage. This includes the **willingness to engage with another specialised discipline in a trusting manner**. While this may sound simple, it is often challenging, and the **need for confidence-building** is evident in almost all Good Practices. The second important topic concerns **risk management**, exemplified by Esmeralda Paupério, who has drawn up a '**Hazard Exposure Map for Cultural Heritage of Museums and Monuments**' for the whole of Portugal. Here, it is explained how satellite data offers applications in both underpinning hazard and risk models and enabling real-time risk response.

With regard to the **necessary qualifications**, it is convincingly argued that heritage institutions do not necessarily need to have them in-house. In the **Kerkennah Island project**, coordinator Katia Schörle organised expertise by asking geoinformation experts from a public organisation to provide and interpret data. It is therefore not a question of building up and maintaining special expertise, but of **knowing how and which human resources can be utilised**. Michelle de Gruchy shows an encouraging path in the Good Practice '**Using Satellite Imagery and Geospatial Information Technologies (GIT) to Support Cultural Property Protection (CPP) in Ukraine**'. She explains how the use of geoinformation data for cultural heritage experts in war zones is possible through a timely **manageable additional qualification**. 'Translating the findings into action is proving to be somewhat challenging' is how Paul Joseph puts his experiences in the Good Practice '**Monitoring of Meadow Orchards**'. He demonstrates that, for a historic cultural landscape, collecting technical data is not enough; **the ability to analyse and implement conservation measures** is also required.

All Good Practices emphasise the **transfer potential**, i.e. that the wheel does not have to be reinvented constantly, but that it is worth finding out what can already be used and which comparable processes can be implemented. In the **Choirokoitia Case Study**, for example, Kyriacos Themistocleous clearly shows the potential for cultural heritage sites facing similar geo-hazard risks (e.g. sites affected by subsidence, landslides or tectonic activity).

In her Good Practice Pattern Extraction Methods and LiDAR Technology for Analyzing and Mapping Archaeological Looting, Maria Danese shows how extensive the transfer potential can be and explicitly refers to the feasibility of 'empowering local institutions to monitor and protect their heritage autonomously'. Several Good Practices like the **INACO project** presented by Alessandra Bonazza and the Practice **Preserving Cultural Heritage of Aquileia and its Territory** by Arianna Traviglia underline that Earth Observation and satellite data can provide **support for policy and decision makers in setting up protection strategies and planning actions** for safeguarding cultural heritage e.g. from climate change impacts, pressures from urban expansion and land-use changes.

However, the Good Practices also highlight **areas for improvement**: Competitive thinking exists at many levels in both areas of work. Competition for funding, access to attractive markets, contracts and economically promising research projects cannot be denied. Young researchers and managers, in particular, are looking for opportunities to gain recognition and be published. While this does show a weakness, it also demonstrates significant potential: possible applications in the cultural heritage sector offer many opportunities that have not yet been fully realised.

The **cultural heritage sector as an attractive market in economic terms** is still far from being recognised, let alone developed. It is striking that none of the Good Practices reaches the **level of a business case**. Although there are service providers who, for example, create scenarios from satellite data for cultural heritage sites, evaluate local earth observation data or organise protective measures, it is obvious that economic cooperation is not yet developed.

Benefits and recommendations

Let's take a look at some of the benefits formulated by the authors of the Good Practices in this brochure from their interdisciplinary experiences - from technical, socio-economic and protection perspectives:

- The use of **multimodal data fusion**, combining satellite imagery, historical maps, and hyperspectral data, allows for a more comprehensive understanding of site evolution. This improves historical reconstructions and conservation strategies;
- Support is provided for informed **decision-making** at a local level regarding protective measures;
- Risk maps and vulnerability assessments contribute to **long-term protection measures**;

- A **better utilisation of existing resources** is encouraged - in terms of both research results and economics;
- **Cost savings** result from an early-stage recognition and averting of risks.

In summary, the following recommendations can be made to staff responsible for cultural heritage sites:

- Let yourself be **inspired and encouraged by our Good Practices**, and do not be afraid to approach the experts identified in them directly.
- **Seek opportunities for exchange with geoinformation experts**, e.g. at conferences, in workshops or even bilaterally.
- **Get involved in networks** and look for knowledgeable and reliable partners.
- There is a growing openness to interdisciplinary projects and the corresponding funding opportunities. It is important to actively and confidently **demand these opportunities** from responsible bodies - both nationally and throughout Europe.

Public and private geoinformation organisations are recommended to

- **Actively seek contact with cultural heritage institutions** and present the possibilities. Problems arising from climate change, for example, have long since become an issue for these institutions and the majority of cultural heritage experts are very open to finding out what support they can get in this highly important area. **Bring the topic of satellite utilisation to relevant cultural heritage events** by promoting the available tools and opportunities - attention is guaranteed.

The most important recommendation for both targeted areas is to **reach a common understanding.** It is still the exception for professionals from the humanities and highly specialised natural sciences to have both academic qualifications and experience. This makes **vocational training all the more important** here and is another finding from the analysis of the Good Practices: vocational training can quickly bring research results and expertise to where they are urgently needed - to the management of cultural heritage sites. This outcome is encouraging, even if our two fields of work still have a long way to go before we have a '**common language**'. The **SATCULT** project has created a forum for doing just that.

Karin Drda-Kühn
SATCULT coordinator

Glossary

Artificial Intelligence (AI): is the simulation of human intelligence in machines that can perform tasks such as learning, reasoning, and problem-solving.

Climate Change: refers to long-term shifts in temperatures and weather patterns, mainly caused by human activities.

Copernicus Programme: is the European Union's Earth observation initiative, providing free and open data from satellites and ground systems to monitor the environment and support policymaking.

CORINE Land Cover: is a European program that provides consistent, detailed land cover maps across Europe.

Corona: are high-resolution aerial photographs taken by U.S. reconnaissance satellites during the Cold War, primarily used for military intelligence and later repurposed for historical and environmental research.

COSMO-SkyMed: is an Italian Earth observation satellite system that uses radar to capture high-resolution images day and night, in all weather conditions.

Cultural Heritage: refers to the legacy of physical artefacts and intangible attributes inherited from past generations, including traditions, languages, monuments, and artworks.

Deep Learning: is a subset of machine learning that uses neural networks with many layers to analyse complex data and make decisions or predictions.

DTM: A Digital Terrain Model is a 3D representation of the Earth's surface, showing elevation data and representing the bare ground without vegetation or structures.

Earth Observation: is the collection of information about Earth's physical, chemical, and biological systems using remote sensing technologies, typically from satellites or aircraft.

Google Earth Engine: is a cloud-based platform for processing and analysing large-scale geospatial data, used for environmental monitoring and research.

GIS: Geographic Information System is a framework for capturing, storing, analysing, and visualising spatial and geographic data.

GNSS: Global Navigation Satellite System is a satellite-based system that provides geolocation and time information to receivers anywhere on Earth.

Hexagon: images are high-resolution reconnaissance photos captured by U.S. KH-9 Hexagon satellites during the Cold War, used for mapping and intelligence, and now valuable for historical and geospatial research.

Hyperspectral satellite data: captures images across hundreds of narrow, contiguous spectral bands, allowing detailed analysis of Earth's surface materials based on their unique spectral signatures.

IoT: The Internet of Things refers to a network of physical devices—such as sensors, appliances, vehicles, and other objects—embedded with software, sensors, and connectivity that enable them to collect and exchange data over the internet without direct human intervention.

IMERG: Integrated Multi-satellite Retrievals for GPM. It's a NASA algorithm that combines data from multiple satellites, including the Global Precipitation Measurement (GPM) core observatory and other satellites, to estimate global precipitation.

InSAR: Interferometric Synthetic Aperture Radar is a remote sensing technique that uses radar images from satellites to measure ground surface movements with high precision.

Land cover: refers to the physical material on the Earth's surface, such as vegetation, water, soil, and urban infrastructure, as observed in satellite or aerial imagery

Landsat: Landsat-8/9 images are multispectral satellite images with moderate resolution, used for long-term monitoring of Earth's land surface.

Land use: refers to how humans utilise land surfaces for activities such as agriculture, urban development, industry, and recreation.

LiDAR (Light Detection and Ranging): is a remote sensing technology that uses laser pulses to measure distances and create precise 3D maps of objects or landscapes.

Machine Learning: is a type of artificial intelligence that enables systems to learn from data and improve their performance over time without explicit programming.

MSWEP: stands for Multi-Source Weighted-Ensemble Precipitation. It is a global precipitation dataset that combines observations from rain gauges, satellite data, and reanalysis products.

Multispectral satellite data: captures images across several broad spectral bands, enabling analysis of land, water, and vegetation by detecting reflected light in visible and infrared wavelengths.

NDVI (Normalised Difference Vegetation Index): is a numerical indicator that uses satellite or drone imagery to measure live green vegetation by comparing reflected near-infrared and red light

Persistent Scatterer Interferometry (PSI): is an advanced InSAR technique that detects and monitors ground deformation over time by analysing stable radar reflectors, known as persistent scatterers, across multiple satellite images.

Planet: Planet images are high-frequency, high-resolution satellite images captured by a fleet of small satellites.

Pleiades: Pleiades satellite images are very high-resolution Earth observation images captured by the Pleiades constellation of satellites, offering up to 50 cm spatial resolution.

Remote Sensing: is the process of collecting information about objects or areas from a distance, typically using satellites or aircraft to detect and measure reflected or emitted radiation.

Revised Universal Soil Loss Equation (RUSLE): is a mathematical model used to estimate soil erosion rates by considering factors like rainfall, soil type, topography, land cover, and management practices.

RTK GPS (Real-Time Kinematic Global Positioning System): is a high-precision positioning technique that uses satellite data and real-time corrections from a base station to provide centimetre-level accuracy.

Satellite Images: are pictures of Earth or other planets captured by sensors on satellites, used to monitor and analyse surface and atmospheric conditions.

Sentinel-1: is a European radar satellite mission that provides all-weather, day-and-night imagery.

Sentinel-2: is a European Earth observation mission that provides high-resolution, multispectral imagery.

Spectral resolution: refers to a sensor's ability to distinguish between different wavelengths of light, with higher spectral resolution capturing narrower and more numerous spectral bands.

Subsidence: is the gradual sinking or settling of the ground's surface, often caused by natural processes or human activities.

A **Total Station** is a surveying instrument that combines electronic distance measurement and angle measurement to accurately determine positions and elevations on the ground.

UAV (Unmanned Aerial Vehicle) photogrammetry: is the use of drones equipped with cameras to capture overlapping images of the ground, which are processed to create accurate 2D maps and 3D models.

UNESCO World Heritage sites: are landmarks or areas recognised for their cultural, historical, scientific, or natural significance, designated for preservation and protection.

UTM zone: is one of 60 longitudinal strips, each 6° wide, used in the Universal Transverse Mercator coordinate system to map the Earth's surface with minimal distortion.

WebGIS: is a web-based Geographic Information System that allows users to access, analyse, and share spatial data and maps over the internet.

Dante Abate
Eratosthenes Centre of Excellence

Acknowledgements

The **SATCULT** team would like to express its sincere gratitude to the following individuals and organisations who have helped us to create this compilation of Good Practices on the levels of content and organisation:

- Special thanks go to the authors of the Good Practices for their trustful cooperation.
- We are greatly indebted to our Advisory Board members for their support in many ways at the national levels.
- Much appreciation goes to Catherine Magnant and Arnaud Van Cutsem of the European Commission's Directorate-General for Education and Culture in Brussels (Belgium) for their organisational support.

Inspiration, recommendations and suggestions were kindly shared by

- Alessandra Bonazza, CNR-ISAC, Bologna (Italy)
- Jens Danzeglocke and Thomas Krauss, German Aerospace Center, Oberpaffenhofen (Germany)
- Benjamin Ducke, German Archeological Institute, Berlin (Germany)
- Athanasios K. Vionis, University of Cyprus, Nicosia (Cyprus)

Brochure Design:

Cultural Heritage Cluster

Eratosthenes Centre of Excellence

Connect With Us!

Contact

Dr. Karin Drda-Kühn - media GmbH (coordinator)

Goethestr. 10, D-97980 Bad Mergentheim/Germany

satcult@media-k.eu

https://satcult.eu

https://www.linkedin.com/groups/13118904/

+49 7931 99 27 30